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Stand Ye Prepared

SUPPOSE the Boss sent for you and asked how much power you were making and how much it cost.

Could you tell him?

The central stations are selling ten or twelve per cent more current each year. More electrical transmission is used even in plants that make their own current.

Suppose the Boss told you that inside of a year he would probably need so and so much more power.

Are you prepared to tell him how much more can be got out of the present plant and what is the best way to do it?

If he tells you that he can buy juice for so much a kilowatt-hour can you tell him how much it will cost a year to run the works and keep up steam for heating and processes, buying the power or continuing to run his own plant?

Can you give him an intelligent idea as to what he would have to spend to put the plant in shape to deliver the additional power required or how you would reorganize the outfit to do it if it were left to you?

Would you put in stokers or powdered fuel or oil, or keep on hand firing?

Would you use your present engines or turbines or new and different ones, or buy your power in whole or in part?

Would you use higher pressure and more or less superheat?

Have you any idea of the efficiency at which you are now running and of how much, under your conditions, this would be improved with reasonable investment?

And of what this would mean on the annual coal bill?

This kind of knowledge is available to the man of ordinary intelligence. The possession of it is what makes a man an engineer.

It is interesting to the Boss. He thinks more of the man who has it and is able to apply it to his problems of management.

Stand ye prepared when he comes around to find how much of it he has in his engineer.

F. R. Low

Waste Heat Boilers

Save $50,000 Per Year

By E. M. CAPELL

Construction Engineer, Portland Gas & Coke Company, Portland, Oregon

Three 5,587-sq.ft. water-tube waste-heat boilers applied to straight-shot oil gas generating sets in the new plant of the Portland Gas & Coke Company saved this large sum over fuel-fired boilers. The boiler-generator cycles have been timed so that a fairly even volume of steam is delivered to the main plant header. Average boiler efficiency exceeds 75 per cent and cleaning of the heating surface has been only a minor problem.

WASTE-HEAT boilers and economizers of various kinds have become standard equipment in the reclamation of waste heat in stack gases of practically all power plants, coke ovens, steel mills, water-gas generating plants and innumerable other industries, where heretofore vast heat wastes have been permitted to exist. Capable engineers have been aware of the enormity of the waste and the substantial savings that might be realized by its utilization, but owing to the hazards involved and previous cheapness of fuels, it is only within the last decade that particular attention has been given to the recovery of the heat from certain industries.

Both fire-tube and water-tube boilers have been used with equal success, the former, however, being used to a greater extent. It would appear that the type to select is dependent entirely on local conditions. At Portland both types were considered, the selection being made chiefly on the following requirements:

Each type of boiler being of varying dimensions, it is preferable to select such a unit as will fit in with existing structures and thereby reduce the cost of installation.

If the gases are heavily laden with cinders or other foreign matter, the boiler should be so arranged that all heavy substances are deposited and consumed if possible, in the entry or forward end of the boiler.

The resistance to the gases through the boiler may be an important feature of the installation, since certain pressures may be available, and if the passages of the boiler produce considerable back pressure on the gases, induced or forced draft may be required.

If the plant steam requirement is such that the boiler capacity is demanded, whether or not waste heat is available, the boiler should also be designed for direct firing.

In addition to the points just outlined, consideration was given to previous performance of boilers installed under similar conditions and also the possibility of utilizing the existing direct-fired boilers, in the event it might prove feasible to generate all the steam required by means of waste heat.

Three in number, the boilers are of the water-tube type designed for 200 lb. working pressure and 100 deg. F. superheat. They have vertical steel headers and cross drums. The headers are double decked, that is, two standard sets of eleven tubes each are erected one above the other, there being twenty tube sections per boiler containing a total of 5,587 sq.ft. of effective heating surface, all of which is supported independent of the setting on a structural steel framework. The setting is of the usual firebrick construction having walls 18 in. thick at the furnace or inlet end and 9 in. thick beyond the bridge wall. The inlet end is of special design in that the bridge wall is placed 9 ft. from the boiler front and extends upward to the tubes, where baffling follows along the tubes to the forward vertical baffle. This construction provides for an abrupt turn in the path of the gases, so that all unburned residue and carbon is deposited beyond the path of the gases, but sufficiently close so that the deposits are consumed by the excess oxygen in the gases. A cleaning door is provided in the side wall close to the bridge wall for use in the event that all of the deposits are not consumed.

There are two vertical baffles in the boiler. The waste gases enter near the bottom, pass upward around the tubes to the top, where the superheater is located, then downward and then upward again at the rear into a 40-ft. stack.

The casing, which is of steel, is of special construction in that it is designed with projecting flanges in order to withstand the pressures which are somewhat higher than are normally experienced in direct-fired boilers. Explosion doors that automatically relieve any excess pressure that might be caused by a gas explosion in the boiler, are provided in the casing. These doors close automatically in the event an explosion has occurred, so that no delay in operation is necessitated.

Boiler Accessories and Equipment

Each boiler is provided with sufficient accessories and equipment to insure safe and efficient operation. Located between the first and second passes, the superheater is designed to maintain 100 deg. of superheat when operating at normal rating. There are ten soot-blower elements so located as to clean the tubes and baffles effectively, these blowers being operated by chains from the operating platform at the floor level. The feed water is handled through a regulator specially designed for maintaining a constant water level. This is essential,

owing to the large fluctuation in the steam made between off and on blast periods.

Water columns also are installed, and these are equipped with high and low electric water alarms and whistles for indication of the high and low water level points. The electric high and low alarms operate lights on the main floor of the generator house to notify the gas machine operator, and the whistles inform the water tender, who looks after several boilers. Steam from each boiler is measured and recorded by a flow meter equipped with a 24-hour chart.

Oil burners have been installed for use when the supply of waste heat is not available. These burners are on the entrance flue and project the flame toward and against the bridge wall. The burner opening is normally closed by a swinging tapered plug of a special thermalloy metal with a plastic firebrick high-temperature face. When the gas generator is out of service, the plug is swung out of place and the burner is swung into position and placed in service. The burner is of the mechanical high-pressure atomizing type, and air is furnished by a turbine-driven fan completely contained in the burner framework. The oil supply to the burner and the steam and exhaust connections of the turbine have flexible swinging joints, so that all piping is connected and ready for use when the burner is swung into position.

Each boiler is installed in connection with and receives the waste-heat products from two straight-shot oil gas generators of 2,500,000 cu.ft. daily gas capacity each. The boiler is on the outside of the building, and the gases pass from each generator through a steel firebrick-lined flue to a common down leg five feet in diameter connecting with a tee to the front of the boiler. On the flue from each generator there are two inclined water-cooled valves that are hydraulically controlled and operate simultaneously. Between the valves is a spacer, which, when the valves are closed, is opened automatically to the atmosphere. This is done to prevent the manufactured gas that might leak past the first valve from entering the boiler and forming a possible explosive mixture in the boiler proper. The seats and disks of the valves are both water cooled, and the amount of cooling water is automatically regulated to maintain a constant temperature in both seat and disk.

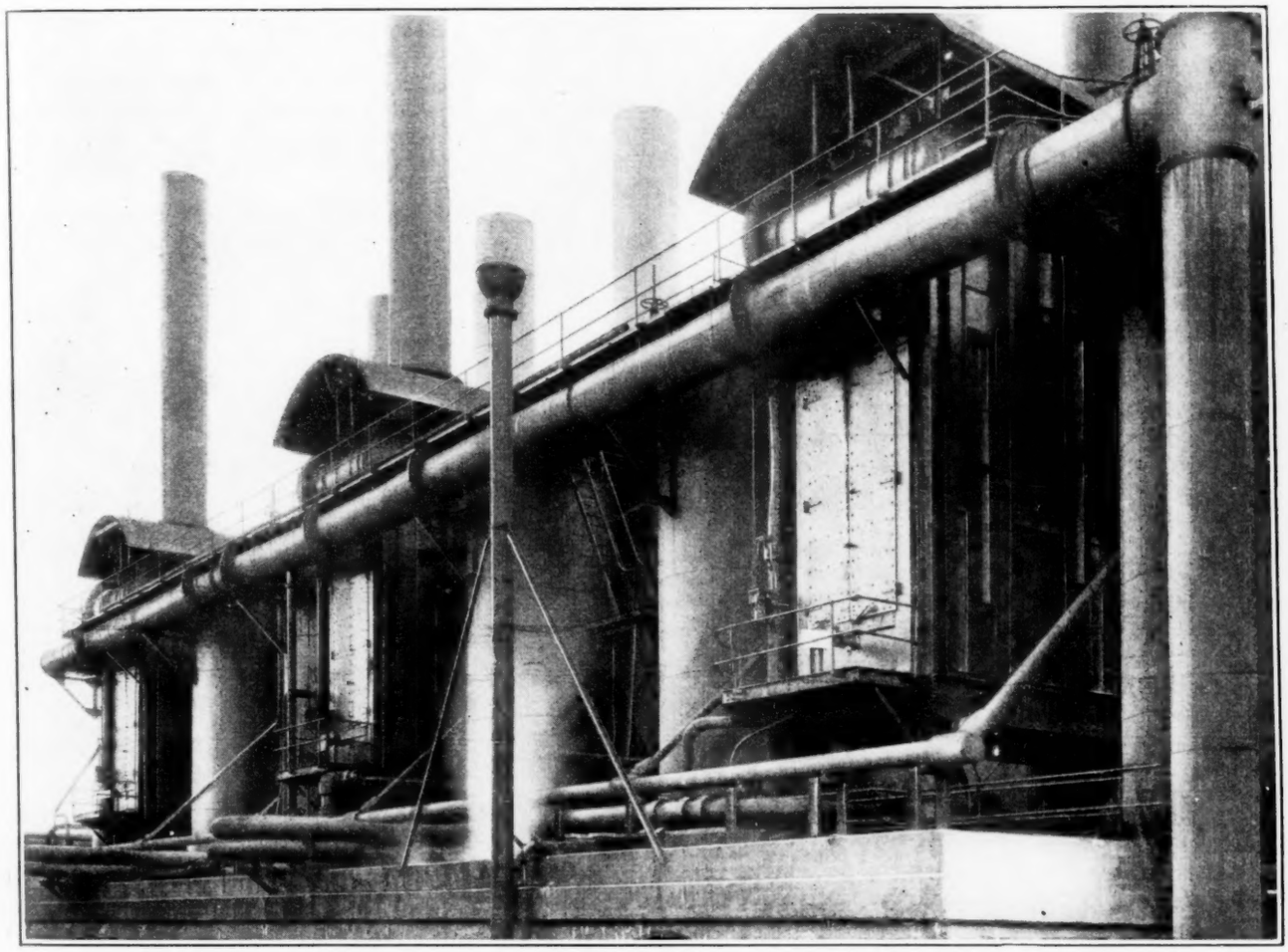


Fig. 1—Waste-heat boiler installation at the new plant of the Portland Gas & Coke Company, Portland, Ore.

The gas generators are operated on a cycle consisting of a making and heating period, and each pair of generators that are connected to one waste-heat boiler are timed so that the heating and making periods alternate. The machines make gas for 24 minutes, blast to the atmosphere for approximately one minute and blast through the waste-heat boiler for 11 minutes. The accompanying curve shows the steam developed by a waste-heat boiler during the cycle of one generator. The

maximum steaming rate obtained during the passage of the waste heat gases is approximately 33,000 lb. an hour, dropping to 9,000 lb. during the off periods. The minimum output developed in operation is maintained by the radiation of the brickwork and consumption of the carbon deposits in the forward end of the boiler. This minimum steaming rate appears to be constant, and it is believed that this condition could not be obtained in a fire-tube boiler under the same operating conditions, in

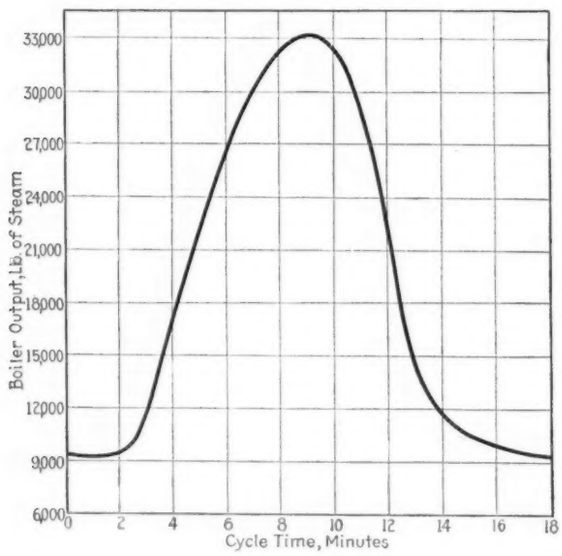


Fig. 2—Curve showing typical average steam flow rates of one waste-heat boiler

that the radiant heat from the brickwork tends to promote the combustion of the deposit, whereas the water cooled surfaces would not produce such a condition.

It might appear that the extreme variation in the steam production would cause much difficulty in the plant operation, but three boilers are connected to the steam header and these are timed so that the peaks in steam production are practically eliminated and a fairly even volume of steam is delivered to the main plant header.

One of the accompanying photographs was taken during the erection of one of the boilers and gives a general idea as to its construction. The other shows the completed installation of three boilers as connected to six generators.

In the lower foreground the expansion loop is a portion of the main steam header to which all the waste-heat boilers are connected. This header is connected at both ends to the main plant header in the power house where the fuel-fired boilers are located. The feed-water and blowoff lines are installed near the steam header. These are interconnected, the waste-heat boilers receiving their feed-water supply from the same pumps and heaters as the fuel-fired boilers and a common blowoff tank is used for all boilers.

When placed in operation, the boilers were tested individually and it was found that each boiler was receiving flue gas at a maximum rate of 98,700 lb. an hour and at an average rate of 53,200 lb. an hour, with an inlet temperature at the boiler front of 1,862 deg. F. The boilers have developed a maximum of 33,360 lb. of steam per hour and maintain an average production of 18,450 lb., with 169 lb. average steam pressure and 103 deg. of superheat.

Gases leave the boiler at a temperature of 458 deg. F., and the draft loss through the boiler never exceeds 2.75 in. of water column and averages 1.94 in. The boilers have proved satisfactory from every point of view, and after taking all factors into consideration, the average efficiency approximates 75.6 per cent.

These waste-heat boilers furnish sufficient steam for all plant requirements during the summer months, and winter peak loads are taken care of by the fuel-fired boilers. Additional saving is effected in connection with these boilers in that the water used for cooling the waste-heat inlet valves is returned to the feed-water heater and is used for boiler feed. The cooling water leaves the valves at approximately 150 deg. F. and consequently little steam is required for feed-water heating and no additional cold feed-water makeup is required.

Generation of steam by the use of the three waste-heat boilers has resulted in an approximate saving of $50,000

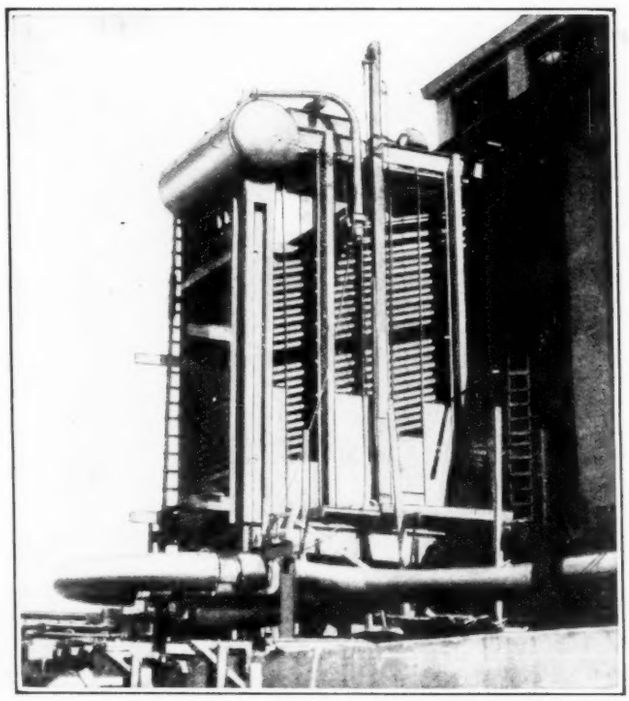


Fig. 3—One of the waste-heat boilers under erection

a year. This figure does not include any investment charges, but deductions have been made for operation and maintenance of the boilers and accessories. From the foregoing it will be seen that the installation of this type of equipment can be made profitable and the heat balance in plant operations greatly improved.

As might be expected, the cleaning of the boilers has not developed into a serious problem, since after being operated for over two years, it is found that each boiler will generate 30 million pounds of steam over an approximate period of 90 days before any cleaning is required.

Modernization vs. Executive Resistance—II*

Mr. Bliman Thinks Things Over

WELL, Joe, I haven't seen you for quite a time Been on your vacation, eh? I wish I could take one, but the way things are nowadays, what with business being what the financial papers call "normal," and foreign competition cutting prices, and me having to make my stuff in my old plant, I don't get any time to take a vacation, and if I did I should be worrying all the time and the chances are that it would do me more harm than good.

Yes, I know things have been pretty much the same for a long time now, and I've managed to get along reasonably well and show a little balance at the end of the year, but with all these new ideas coming along things are getting different, and now some of these darn fools 'round

It's what those wise guys call a vicious circle and believe me it looks pretty vicious to me just now

here are getting bitten with this new power plant craze, and I'm none too sure what's going to happen in the next few months.

There's the Ideal Mills just over there; they started up their new 400-lb. plant a month ago and, believe me, if what Jim says is right, it's going to make us all sit up and watch. He tells me that they are making a saving that will cut off four dollars a ton from the cost of their product, and that means they can undersell me just that much. I've always figured on doing a little better than fifty-fifty with them in local business, but I find that already I'm losing orders I ought to get and it's got me worried.

My low overhead? Yes, I know I may keep my capital down by not buying a modern plant, but if I don't get the business, how does that help my overhead?

If my sales go down and my capital remains the same, my overhead per ton goes up, doesn't it? And then I've either got to sell at a loss or put my price up, and then I lose more business and my overhead goes up again. It's what those wise guys call a vicious circle and, believe me, it looks pretty vicious to me just now.

No, of course I'm not going back on what I said about not getting a new power plant. I stick to every word of it, and I know I was right. Still, some of the most famous birds in history have been known to change their minds, haven't they? Why, even the Prince of Wales changes his mind nearly every time he gets on a horse, don't he?

But that doesn't say I'm going to change mine; not by a long way, no sir! But I've just been thinking things over and keeping my eye on what other people are doing. I went up to the annual meeting of our branch of the Association the other day, and I tell you it opened my eyes. A lot of these real hard-boiled eggs seem to be softening up all ready for the come on, and I can't make up my mind whether it's all part of a big game to sell a bunch of equipment or whether there really is something in it. But I'm not going to change my mind; I got it all argued out with logic and there's no getting 'round it. I don't know who put that article in *Power*[1] (No, certainly I did not!), but when I read it and saw how clearly I had proved that these so-called modern plants are all a fake, I patted myself on the back, and why not? It's not every man can make a bold stand against what the newspapers call "extravagant innovations" and show so clearly and simply just why they could not possibly pay. I wish I'd thought of all that before the Ideal Mill people had started to put in their new plant; maybe they would never have changed from their old plant, and then they wouldn't be underselling me today. Not logical, you say; *me* not logical! Well I'm practical, anyway.

Well, my engineer keeps worrying me and getting me all upset, and I can't fire him even if I said I would; I may need him presently. But I wish he wouldn't keep rubbing it in, because I won't be rushed into anything. There's many a young fellow who makes the mistake of being too persistent and setting his employer's back up by continually rubbing it in, instead of leaving just a little time between applications to give the medicine time to work.

He's a pretty good fellow all right and means well, but when it comes to argument he can't put one over on me. He was talking the same old stuff yesterday and I asked him all of a sudden, "Jim, how long is it since all these new power plants you talk about started to be developed?" "Oh about three or four years," he says. "Well, suppose in three or four years' time other improvements come along which would make your new plant out of date? I'd look pretty sick, wouldn't I, after spending all that money!" That set him back a bit, though he wouldn't show it and said something about its being unlikely and that the equipment would have paid for itself in three years anyway, also that it was necessary to design for probable future developments, not for improbable ones, but I didn't pay much attention to him. I found it helps a lot when you know you are right, not to take too much notice of what the other fellow says even though his arguments may appear plausible on the surface.

Besides, as I said before, I'm thinking things over, and thinking hard.

*The second article of a series providing a sequel to an article which appeared in *Power* of May 10, 1927, under the title, "Why I am not going to modernize my plant."

[1]May 10, 1927, issue: "Why I Am Not Going to Modernize My Plant."

Combustion Control Formulas

V—Simplifying the heat loss formulas

By E. A. UEHLING
M.E., Dr. of Engineering

IN THE previous article the application of the heat loss equation to boiler test data was illustrated. These equations can be further simplified so that every-day use for combustion control may be accomplished with the least amount of time and trouble.

Formula 1, $\left(0.24 + \frac{58.6}{CO_2}\right) \times (T - t)$ = B.t.u. of sensible heat lost in the dry flue gas, is composed of two factors. The first term represents the heat in B.t.u. per degree of temperature contained in the weight of dry gas produced in burning one pound carbon unit of fuel with an excess of air of which the per cent CO_2 is the index. The second term $(T - t)$ represents the difference in temperature between the gas on leaving the boiler

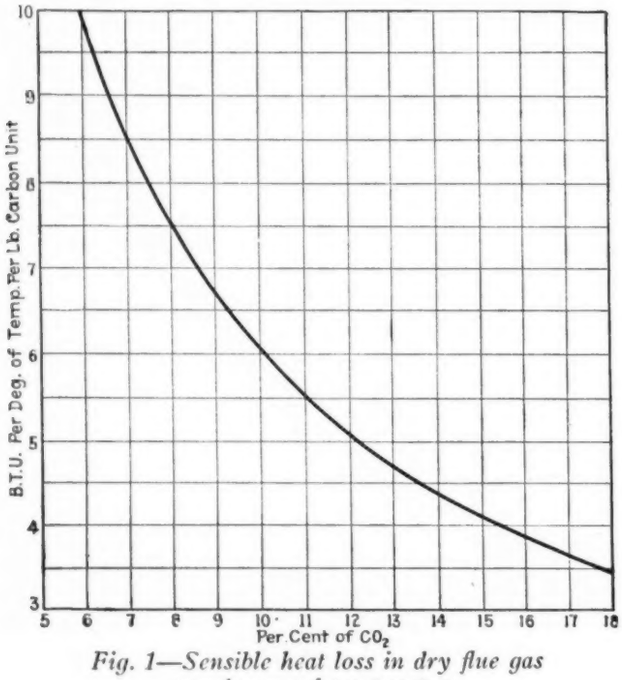


Fig. 1—Sensible heat loss in dry flue gas per degree of temperature

and that of the atmosphere. Formula 1 can be written,

$$\left(0.24 + \frac{58.46}{CO_2}\right) \times T - \left(0.24 + \frac{58.46}{CO_2}\right) \times t.$$

The first term represents the sensible heat in the dry flue gas above zero temperature, and the second term represents the sensible heat in the dry flue gas contributed by the air. Hence, the difference between the two has been contributed by the fuel burned. According to the approved method of boiler testing the heat brought in by the air is deducted from the heat carried to waste by the gas, because this heat is not derived from the fuel burned.

If it is assumed t = zero, then Formula 1 is greatly simplified without affecting its accuracy for controlling the heat loss up the chimney, because $\left(0.24 + \frac{58.46}{CO_2}\right) \times T$ = total heat in the dry gas above zero irrespective

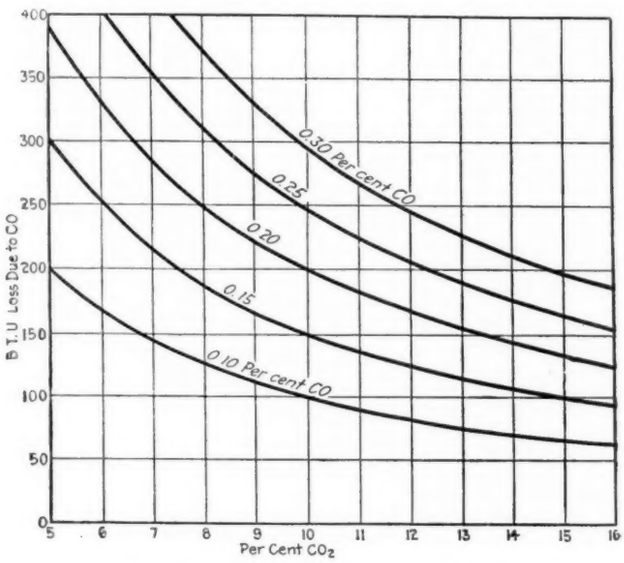


Fig. 2—Heat loss in flue gas due to incomplete combustion

of its source. Substituting X for the first term of this equation the very simple Formula 1a, $X \times T$ = B.t.u. total sensible heat contained in the dry gas, is obtained.

The value of X can be predetermined by using the curve in Fig. 1 and the calculation required to determine the sensible heat in the dry gas is reduced to one simple multiplication.

The curves in Fig. 2 are plotted from the formula $10{,}160 \times \frac{CO}{CO + CO_2}$ = B.t.u. loss due to incomplete combustion, and their use greatly simplifies the determination of this loss.

The heat contained in the wet gas, neglecting the moisture brought into the furnace by the air, is given by Formula 3, $H_t \times (10{,}640 - 9t + 4.3 \times (T - 212))$ = B.t.u. per pound carbon unit of fuel burned. The heat in the wet gas consists of two parts, *a*, $H_t \times 10{,}649$

B.t.u. of latent heat and b, $H_t \times (4.3 \times (T - 212) - 9t) = B.t.u.$ of sensible heat. The former is entirely unavailable to the boiler, and the latter is only partly available.

One of the distinctive characteristics brought out by the development of the pound carbon fuel unit is that the ratio of the available hydrogen to the total carbon is practically constant in each class of fuel This also holds practically true for the ratio of the total hydrogen in the fuels when free from moisture. These ratios are given in the table.

It is evident, since the latent heat carried to waste by the wet gas depends solely on the weight of total hydrogen, which is practically constant per pound carbon unit in each of the respective types of dry fuel, that the heat loss due to hydrogen is also constant. As latent heat is not available to the boiler and cannot be reduced the slightest degree, it cannot be controlled. The sensible heat in the wet gas is a minor loss factor. It is controllable by the temperature of the gas and is therefore automatically controlled by control of the temperature.

Formula 4, $Av \times \left(\frac{117}{CO_2}\right) \times (T - t)$ represents the heat loss due to the humidity in the air. The heat loss represented by this formula is small and is automatically controlled by controlling the excess air. For control purposes it can be ignored, but must be considered when making a heat balance.

In addition to knowing how to calculate the heat losses, it is sometimes desirable to determine the weight of the air supplied, the weight of the flue gas produced and the per cent of excess air. The pound carbon fuel unit is well adapted for the development of simple formulas for determining these factors, and all calculations are based on the per cent of CO_2.

RATIO OF HYDROGEN TO CARBON

	H_a	H_t		H_a	H_t
Anthracite	0.029	0.032	Sub-bituminous	0.045	0.074
Semi-bituminous	0.049	0.054	Fuel oil	0.144	0.144
Bituminous	0.054	0.066	Natural gas	0.306	0.306

The theoretical minimum volume of air required to burn one pound of carbon to CO_2 is 143.7 cu.ft. at 32 deg. F. Also one molecule of oxygen combines with one atom of carbon and forms one molecule of CO_2. It follows from Avogadro's law that the per cent of oxygen contained in the air bears the same relation to the per cent of CO_2 in the gas that volume of air supplied bears to the theoretical volume of air required for complete combustion. Thus, if the volume of air supplied equals A, then $\frac{21}{CO_2} = \frac{A}{143.7}$ and $A = \frac{21 \times 143.7}{CO_2} = \frac{3{,}018}{CO_2}$ cu.ft. per pound of carbon burned.

This equation gives correct results when burning coke or charcoal, but, when the fuel contains hydrogen, as all natural fuels do, the oxygen[1] required to burn the hydrogen must be added. Oxygen at 32 deg. F. weighs 0.0892 lb. per cu.ft., and the volume of the eight pounds of oxygen required to burn one pound of hydrogen is $\frac{8}{0.0892} = 90$ cu.ft. If H_a represents the weight of available hydrogen per pound carbon unit of fuel, then the equation becomes Formula 7, $\frac{3{,}018}{CO_2} + 90\ H_a =$ cu.ft. of air supplied per pound carbon unit of fuel burned, and since air and oxygen weigh respectively 0.0807 and 0.0892 lb. per cu.ft., we have Formula 8, $\frac{243.6}{CO_2} + 8\ H_a =$ lb. of air supplied per pound carbon unit of fuel burned.

HEAT LOSS FORMULAS

Formula 1: $\left(0.24 + \frac{58.46}{CO_2}\right) \times (T - t) =$ B.t.u. of sensible heat in dry gas per pound carbon unit.

Formula 2: $10{,}160 \times \frac{CO}{CO + CO_2} =$ B.t.u. heat loss per pound carbon heat unit due to incomplete combustion.

Formula 3: $H_t\ [(10{,}640 - 9t + 4.3 \times (T - 212)] =$ B.t.u. heat loss due to hydrogen in the fuel per pound carbon unit.

Formula 4: $Av \times \left(\frac{117}{CO_2}\right) \times (T - t) =$ B.t.u. heat loss due to humidity in the air per pound carbon unit.

Formula 5: $\sqrt{Bd} \times CO_2 =$ index of the rate of combustion.

Formula 6: $\sqrt{Bd} =$ index of the normal exit gas temperature.

Formula 7: $\frac{3{,}018}{CO_2} + 9\ H_a =$ cu.ft. of air per pound carbon unit.

Formula 8: $\frac{243.6}{CO_2} + 8\ H_a =$ lb. of air per pound carbon unit.

Formula 9: $1 + \frac{243.6}{CO_2} + 9H_t =$ lb. of wet gas per pound carbon unit.

Formula 10: $\frac{2{,}100}{CO_2 \times (1 + 3H_a)} - \frac{100 + 237H_a}{1 + 3H_a} =$ per cent excess air

Formula 11: $\frac{21}{1 + 2.37\ H_a} =$ Maximum CO_2

Weight of Gas Produced

The total weight of the gas produced per pound carbon unit of fuel burned is equal to the weight of the air supplied plus the weight of the combustibles consumed. The weight of the combustibles per pound carbon unit is one pound of carbon plus the weight of total hydrogen (H_t) and oxygen contained in the fuel. The weight of air $= \frac{243.6}{CO_2} + 8\ H_a$, Formula 8, and adding to this the weight of the combustibles the formula for the weight of wet gas becomes

[1] The nitrogen brought in with the oxygen required to burn the hydrogen is included in equation $A = \frac{3018}{CO_2}$

$\frac{243.6}{CO_2} + 1 + 8\,H_a + 8\,(H_t - H_a) + H_t =$ Formula 9,

$$1 + \frac{243.6}{CO_2} + 9\,H_t = \text{pounds of wet gas}$$

per pound carbon unit of fuel burned, in which $8(H_t - H_a)$ equals the weight of oxygen combined with the unavailable hydrogen in the fuel, that is the part of it which is already in the form of H_2O. The weight of the dry gas equals $1 + \frac{243.6}{CO_2}$.

Per Cent Excess Air

$$\text{The per cent of excess air} = \frac{\text{volume of excess air} \times 100}{\text{theoretical volume of air}}$$

In Article III it was demonstrated (in equation C) that $\frac{21 \times 143.7}{CO_2} = 143.7 +$ excess air, when burning carbon. When the fuel contains available hydrogen H_a the nitrogen which accompanies the oxygen required to burn the hydrogen is $N_h \times H_a$, which must be added to the second term of this equation so that $\frac{21 \times 143.7}{CO_2} = 143.7 + N_h \times H_a +$ excess air, from which, Volume of excess air $= \frac{21 \times 143.7}{CO_2} - 143.7 - N_h \times H_a$. The cubic feet of air required to burn one pound of hydrogen is $\frac{34.8}{.08073} =$ 431 cu.ft., therefore when the fuel contains hydrogen, the theoretical volume of air required to burn one pound carbon unit of fuel is $143.7 + 431\,H_a$ cu.ft.

Since the air is composed of 21 per cent of oxygen and 79 per cent nitrogen, we have $431 \times 0.79 \times H_a = 340\,H_a =$ cu.ft. of nitrogen per pound carbon unit burned. Inserting this value of N_h, the volume of excess air becomes $\frac{21 \times 143.7}{CO_2} - 143.7 - 340\,H_a$. Substituting this value of excess air and the theoretical minimum air required for complete combustion, the equation for per cent excess air becomes

$$\frac{\left(\frac{21 \times 143.7}{CO_2} - 143.7 + 340\,H_a\right) \times 100}{143.7 + 431\,H_a}$$

Reducing this equation to its lowest term by dividing both numerator and denominator by 143.7 and multiplying by 100, we have Formula 10,

$$\frac{2{,}100}{CO_2 \times (1 + 3\,H_a)} - \frac{100 + 237\,H_a}{1 + 3\,H_a} = \text{per cent excess air.}$$

The Maximum Per Cent of CO_2

The theoretical maximum per cent of CO_2 results when the fuel is completely burned with the theoretical volume of air required for complete combustion. Since air contains 21 per cent oxygen, the theoretical per cent of CO_2 will equal (Formula 11),

$$\frac{21 \times 143.7}{143.7 + 340\,H_a} = \frac{21}{1 + 2.37\,H_a} = M\,CO_2.$$

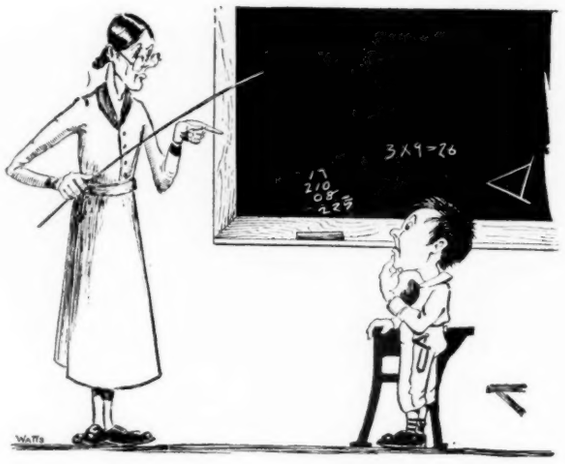
In the average boiler plant the fuel used is restricted to one of the six fuel types. The formulas for weight of air supplied, weight of gas produced, per cent excess air and maximum per cent CO_2 all contain the variable H_t or H_a. By inserting for H_t and H_a the constant value for the type of fuel used these formulas may be greatly simplified, and for bituminous coal become:

$$\text{Pounds of air supplied} = \frac{243.7}{CO_2} + 0.43$$

$$\text{Pounds of flue gas} = \frac{243.7}{CO_2} + 1.59$$

$$\text{Per cent excess air} = \frac{1{,}807}{CO_2} - 97.12$$

$$\text{Maximum } CO_2 = \frac{21}{1.13} = 18.6$$



What Do You Know?

By L. H. Morrison

The answers are on page 10

Ques. 1—Why can steam be used expansively in a crank and flywheel pump, while a direct-acting steam pump must take steam full stroke?

Ques. 2—Assuming you have a motor-driven centrifugal pump that will satisfactorily raise water of 150 deg. F. temperature, 22 ft. when located at Philadelphia, Pa., will this pump raise water at the same temperature the same height when re-installed in Colorado where the atmospheric pressure is 12 lb. absolute?

Ques. 3—Would it be possible for a hoisting engine to raise a load that has been started, when the load is too heavy for the hoist to lift from rest?

Ques. 4—Why should the rams of an underfeed stoker be kept in action as long as there is any air pressure beneath the stoker?

Ques. 5—Why is it that in Canada and other northern countries, ice skates are made with narrow blades, while farther south a wider blade is more acceptable?

Ques. 6—How are the stems of the steam valves of a Corliss engine attached to the valve?

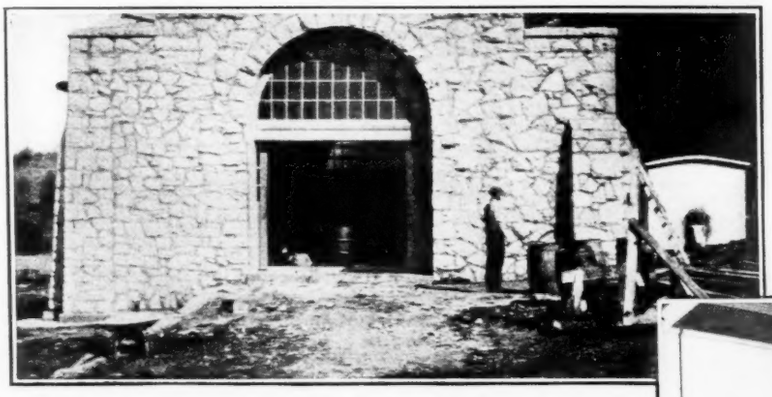
Ques. 7—What is meant by "factor of evaporation"?

Ques. 8—Will the fuel consumption per brake horsepower of a Diesel engine be greater or less at an altitude of 5,000 ft. than at sea level?

Ques. 9—How much moisture can a coal contain and still be susceptible of satisfactory pulverizing?

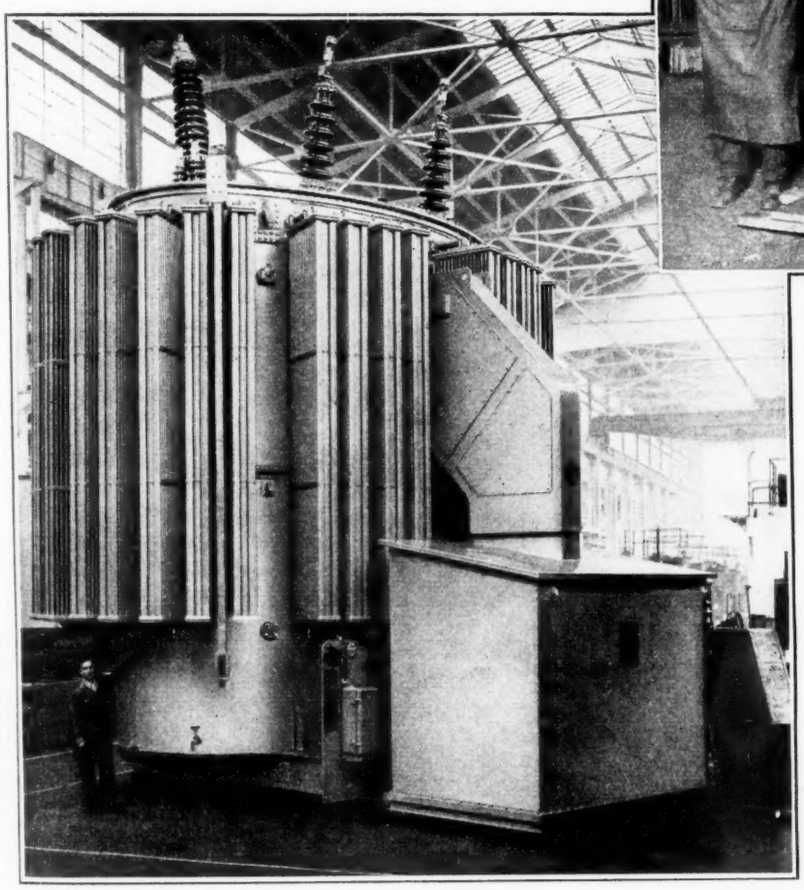
Ques. 10—If on a two-pole direct-current motor one of the field coils was to burn out, what would be the most likely cause of the trouble?

POWERGRAPHS



Left—Power plant of Kern Marble Company near Knoxville, Tenn. This plant is built of white marble and supplies power to the marble works.

Right—One of the largest motor-operated field rheostats built by the Cutler-Hammer Manufacturing Company and is to be used with a 27,500-kva. generator. The rheostat is built in two sections, only one section being shown in the figure. Each panel has 188 segments with 180 steps of resistance. The segments are divided into four sections, which are staggered in relation to each other so that 175 current changes are made. The rheostat has a maximum current capacity of 1,250 amperes



Left—One of the seven 33,000-kva. power transformers built by the Westinghouse Electric & Manufacturing Company for the Conowingo development near Baltimore, Md. Each transformer is over 31 ft. high, weighs more than 200 tons and is designed for 220,000 volts on the high-voltage side. The seven transformers required 20 carloads of oil for insulating and cooling

INTERNAL COMBUSTION ENGINES

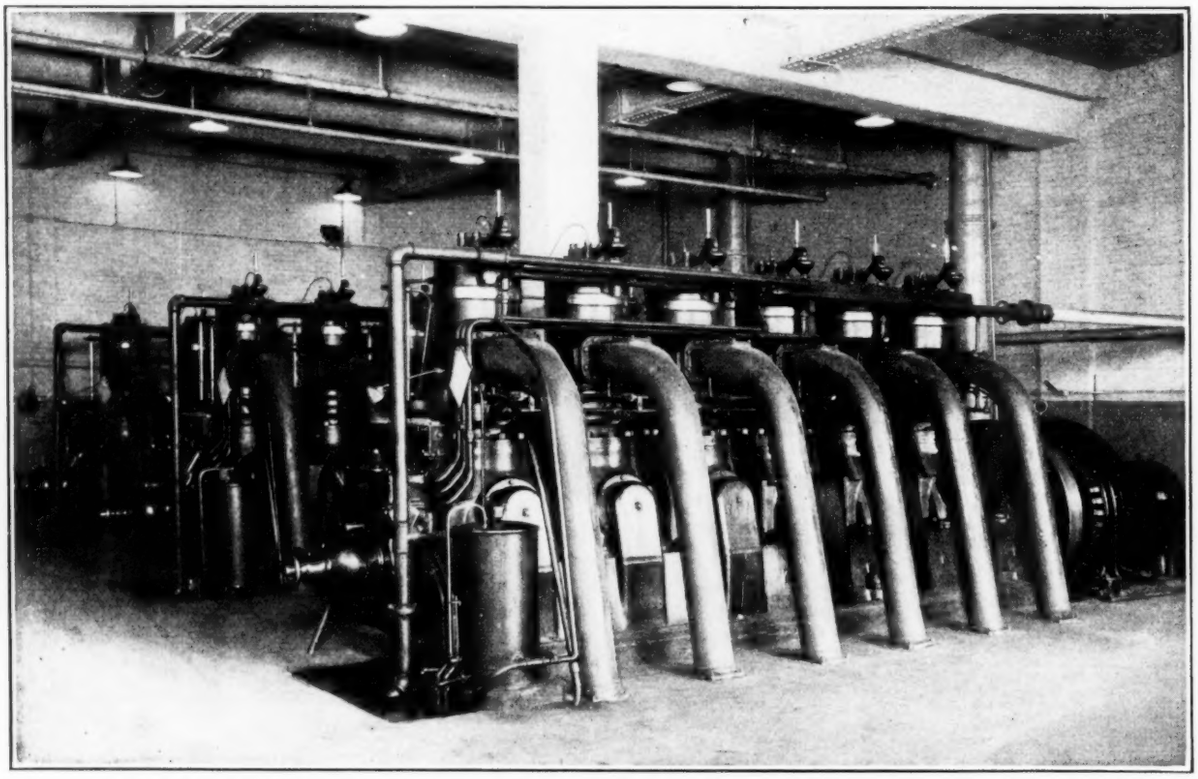


Fig. 1—The three Diesel engines in power plant of Gates & Company

A Diesel Plant In Metropolitan New York

By G. Grow

TWO features make the 1,060-hp. Diesel plant of the Gates Company outstanding. It is within the confines of metropolitan New York City, where there exists a more or less general belief that isolated plants are not economical in view of the low cost of purchased power. In addition the power plant supplies the energy used in the lumber yard and planing mill, the waste of which, one would naturally think, would make a steam plant the more economical.

Up to 1927 this company showed a total connected load in motors of slightly over 2,200 hp. There has been added since then about 150 hp. with 200 hp. more in sight for new derricks under construction. With but one or two slight exceptions all of these motors are ball-bearing 40-deg. machines.

Years ago, when the market was very poor for sawdust, the only real byproduct of the lumber industry, it was found economical to divert all waste wood and shavings to the boiler room, produce steam and generate electricity through the use of steam engines for this plant. However, as years rolled on and an attractive market gradually developed for sawdust, the officials of this concern saw the economy of purchasing their electrical energy and selling the sawdust. A contract of some years' length was accordingly entered into with a New York City public utility for the necessary requirements.

The limitations placed upon the lumber company by this contract in the form of penalties for operating after 4 p.m. owing to the heavy lighting peak encountered by the public utility from that time on each day, together

INTERNAL COMBUSTION *Engines*

with other items of a miscellaneous nature, among them interruptions to service, indicated long before the expiration of the contract that to contend with these things even at the comparatively low cost of three cents per kilowatt-hour was uneconomical.

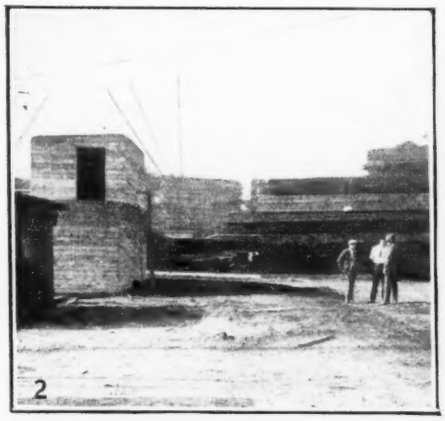
Thoughts were again turned to the operation of the lumber company's own generating plant once more, and a study of modern generating equipment was made. Many plants of all types from coast to coast were studied by Gates & Company representatives, and the conclusion was that a superiority was evidenced by those plants in which Diesel oil engines were the prime movers.

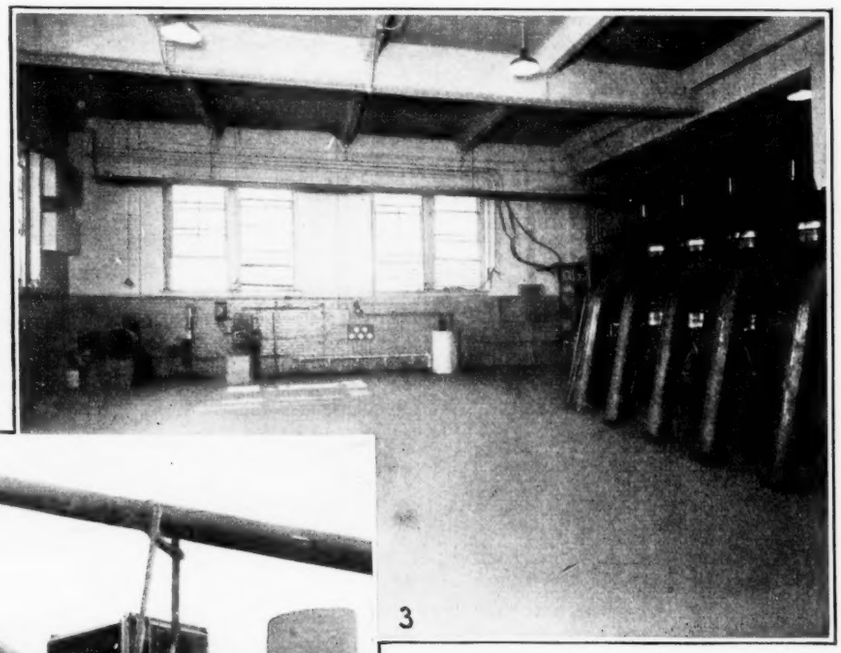
After study of existing types of Diesel engines and an analysis to determine the practicability of applying this type of equipment to this particular mill, a contract was entered into on Jan. 3, 1927, with Fairbanks Morse & Company to furnish and install a complete Diesel engine generating equipment.

In short order the old steam equipment, which was still in the power house, was removed and in its place were installed three 360-hp. Diesel engines, each direct connected to a 300-kva. 40-deg. three-phase 60-cycle 440-volt engine-type alternator, together with a direct-connected 10-kw. exciter for each alternator. A complete four-panel switchboard was installed, not only containing all of the ordinary control equipment, but further improved in its usefulness by voltage regulator, recording watt-hour meter, and syncroscope.

Duplicate air-starting equipment, consisting of one gasoline-engine-driven and one motor-driven two-stage air compressors, together with sufficient air receivers and control was installed.

Two 18,000-gal. fuel-oil storage tanks were provided and embedded in concrete in accordance with the New York City Fire Underwriters Laws. A motor geared to a Blackmere rotary pump is mounted on the top of these tanks in the concrete house shown in Fig. 2, and transfers the oil to a day tank buried beneath the engine-room





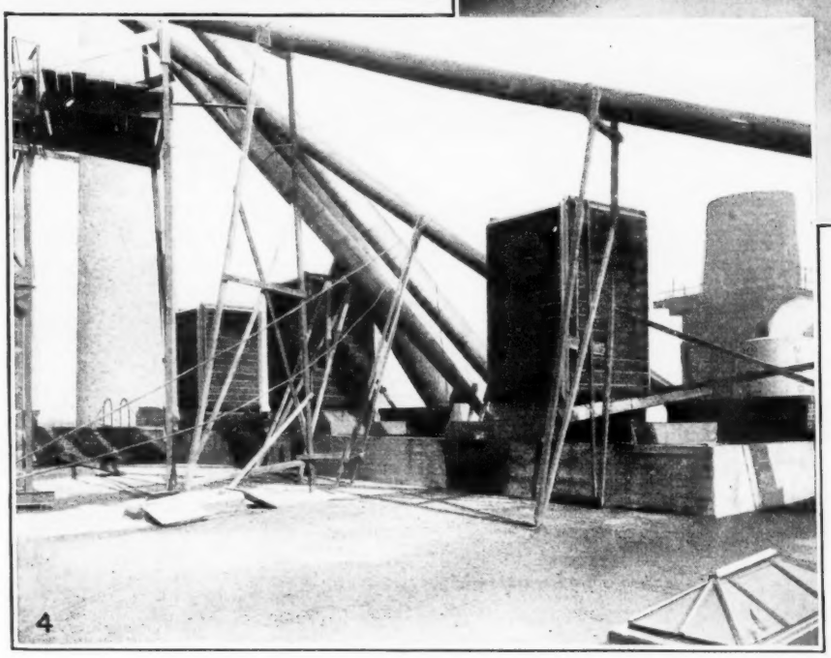


Fig. 2—Concrete housing over the fuel tanks

Fig. 3—The auxiliaries are placed along one side of the engine room

Fig. 4—The three cooling towers on the roof

INTERNAL COMBUSTION *Engines*

floor; during this transfer oil is accurately metered. A De Laval centrifugal oil separator is used to recover the lubricating oil after it has passed through the engine.

A novel water-cooling system was devised by making use of an old underground cistern formerly used for boiler water. This well is filled by city water, and losses by evaporation are automatically replaced through a ball cock on the city supply. From this well and at the rate of 450 g.p.m., water is pumped by a motor-driven centrifugal pump to the roof of the power plant and distributed through three Bink spray-nozzle units, each group containing five nozzles. The resultant spray is permitted to trickle down over $\frac{3}{8}$x5x12-ft. louvered towers, all suspended over a concrete catch basin, as shown in Fig. 4. This cooling equipment was designed to produce, if necessary, a 180-deg. temperature change because of the humid conditions existing around this section during the summer months.

The concrete catch basin is designed to hold sufficient water to flow by gravity through the engines for fifteen minutes after they are shut down. This produces an even cooling effect, and the system is so arranged that it drains itself and all outside pipes completely, thereby precluding the possibility of freezing in winter weather.

Actual checks on cost of operation have been kept since May 16, and up to Oct. 28, 1927, it had been found necessary to operate but two of the three units; 320,000 kw.-hr. was generated in that period. Accurate checks on fuel consumption costing 6½c. per gal. and on lubricating oil costing 57c. per gal. have shown for this period an average of less than 0.8c. per kw.-hr. operating costs, including attendance at $42 a week.

Operating conditions in this particular plant are quite bad, principally because of the great variation in load caused by the on and off crane and derrick loads. It is not an uncommon thing to see the load rush up to 500 kw. and in the next instant drop back to 180, but this condition is so readily handled by the sharp governing of the engines, together with the positive action of the voltage regulators, that no one, unless he is watching the graphic meter, would know it happened.

Diesel Fuel Specifications Need Standardization

By L. H. Morrison

STANDARDIZATION, if carried to excess, may deaden originality and prevent progress, but this is not always true. At the present time users of oil engines are experiencing a real need for a standardized fuel oil capable of being used in most if not all engines, and obtainable at a fair price. The lack of this fuel has done much to unsettle conditions and has been of influence in the wider use of Diesel engines.

An examination of the recommendations of a great number of engine builders reveals that there is but little similarity in the required characteristics of the fuel oil to be used. These are shown listed in the tabulation. Engines marked *A*, *B* and *C*, are two-stroke-cycle air-injection Diesels ranging from 500 to 4,000 hp., *D*, *E*, *F* and *G* are four-stroke-cycle solid-injection engines ranging from 50 to 1,500 hp., while *H* is a two-stroke-cycle and *I* is a four-stroke-cycle air-injection unit.

It would naturally be thought that the cycle on which an engine operates might have some controlling influence. For example, it has been claimed at times that due to the absence of exhaust valves, a two-stroke-cycle engine could handle a poorer grade of oil than could an engine with exhaust valves. Examination of the table does not fully substantiate this idea. It will be seen that the two-stroke-cycle engines *A* and *C* set no limitation on the sulphur, nor does the four-stroke-cycle solid-injection engine *G*, while *B* will permit as much as 2.5 per cent. On the other hand, *D* and *E*, engines quite similar to *G*, being four-stroke-cycle solid-injection engines, both set the limit at 0.5 per cent, while *F*, almost identical with *G*, goes to 3 per cent. The two-stroke-cycle solid-injection engine *H* places the high limit at 1 per cent, and *I*, the air-injection four-stroke-cycle engine, is satisfied that 1 per cent is high enough. Evidently, no cycle limitations control the sulphur content, nor does the use or non-use of air for injection purposes determine the maximum percentage.

In spite of this the table reveals that there is a range of permissible sulphur content from 0.5 to 3½ per cent when a limitation is made by the engine builder.

On the other hand, the flash points seem to be consistent, due no doubt to the Fire Underwriters' requirements.

Those who have operated Diesels have at some time had a tank of oil containing too much water. The engine would run erratically and fail to fire continuously. This might be taken to indicate that water was a prohibited constituent of the fuel. Still, a small amount of water causes no operating difficulty, and experience indicates that its greatest disadvantage is that, although having no heat value, it is paid for at the price of oil. But just what the limiting water content should be, from an operating point of view, seems unsettled. Four engine builders place it at 1 per cent, while several ignore it altogether, and one sets it at one-half of one per cent. Ash, a substance that might score cylinder walls, is limited to 0.1 per cent by several, while two builders require it to be one-half of this amount.

Viscosity is of little moment save as an indication of the ability of the fuel to flow through the oil lines. Still, there is no agreement shown in the tabulation, and most builders fail to mention it in their specifications.

On the supposition that no mention of acid is intended to mean that the oil must be free from acid, it seems that this characteristic is treated more consistently than is any other. Residue or coke ranges from 15 per cent to 0.5 per cent, and neither cycle nor fuel-injection types seem to be influential.

Gravity varies from as low as 18 to a maximum of 26 deg. Baumé. This in spite of the fact that many engines are operating with 12 to 16 deg. oil with satisfactory results. Undoubtedly, an oil of 28 deg. is more satisfactory, so far as operating conditions are con-

cerned; consequently, the builder is not to be blamed if he recommends the use of a high-gravity oil, but the lighter one is justified only when the price differential is small or the yearly fuel cost low.

Even when two builders make use of the same gravity requirements, the other characteristics are not similar in any two specifications.

The obstacles of the procedure are more obvious in marine work. The oil companies cannot carry several different grades of Diesel oil in their fueling stations. On the other hand, Bunker C can be used in most boiler oil burners and the steamer can fuel at any station.

It is possible that engine design has some influence as to the oil to be used. In order to clarify the existing situation, engine builders should get together and adopt one or more standard specifications to permit the oil refiners to supply Diesel fuel at the lowest possible price. If an engine owner desired to use a better grade oil, he could obtain it at a higher price, but the standards would give the average operator some idea as to how cheap an oil he should use.

DIESEL FUEL SPECIFICATIONS

	A	B	D	E	I	F	G	H	C
Flash	150	150	175	..	150	150	...	100	200
Burning point, deg. F	...	...	...	...	.....	...	...	.....	350
Sulphur, per cent	...	2.5	.5	.5	1	3	...	1	...
Water, per cent	1.	1	.5	0	2	1	...	1.	...
Ash, per cent	...	.05	0.1	.1	.1	...	.05	...	...
Viscosity, sec	100	...	...	..	100	150	...	750*	...
Acid, per cent	None	Trace	...	..	Low as pos.	...	...	.....	...
Residue, per cent	...	...	3	1	.....	.5	5.	5	15
Gravity, deg. Baume	...	...	22	...	18	...	...	22–40	26
B.t.u.	.....	18,500		18,000	18,500	18,500		18,000	18,500

*At operating temperature.

Answers to What Do You Know

The questions are on page 96

Ans. 1—If a pump possesses a flywheel, during the early part of the expansion stroke, when the force exerted by the steam exceeds the water resistance, part of the work done by the steam is absorbed by the flywheel. During the later part of the stroke, when the water resistance is greater than the steam pressure, this energy is returned to the crankshaft. In a direct-acting pump the lack of a flywheel compels the steam cylinder to take steam full stroke. However, there have been forms of direct-acting pumps which, by compensating cylinders and inertia weights, have given more or less the same result as the flywheel.

Ans. 2—Water at 150 deg. F. exerts a vapor pressure of 3.7 lb. per sq.in. At sea level the difference between the atmospheric pressure and this vapor pressure, 14.7 — 3.7 = 11 lb., serves to give a velocity to the water in the suction line, to overcome pipe resistance and to raise the water. In Colorado the atmospheric pressure is but 12 lb. and as 3.7 lb. is the vapor pressure there is then but 12 — 3.7 = 8.3 lb. left to overcome friction, etc. Obviously, this is not enough, and the pump will not lift the water 22 feet.

Ans. 3—In lifting a load a hoist must supply enough power not only to balance the weight, but also to accelerate the load. This acceleration usually is greater at the start of the lifting, and consequently it might be possible for a hoist to lift an excessive load if the initial acceleration were brought about by some other agency. The practice is obviously not to be recommended.

Ans. 4—It is not necessary to keep the ram in action. In fact, in case of a sudden decrease in the load it may be wise to stop the ram and permit the fuel bed to burn down. Upon restarting the ram, however, one must be careful not to throw the entire bed of coked fuel to the end of the stoker.

Ans. 5—The weight of the skater exerts enough pressure on the skate blade to cause the ice to melt. One actually skates on a thin film of water. In northern districts the ice temperature is such that to cause melting the blade unit pressure must be high; this calls for a narrow blade. Farther south a wide blade is sufficient to melt the warmer ice.

Ans. 6—The valve stem is provided with a T-head which fits into a slot in the end of the Corliss valve.

Ans. 7—To evaporate one pound of water that is at a temperature of 212 deg. F., into dry saturated steam at the same temperature, and therefore at atmospheric pressure, requires the addition of the heat of vaporization corresponding to that pressure, which is 970.4 B.t.u. per lb. This is what is meant by evaporation "from and at 212 deg. F." Under usual conditions feed water enters the boiler at some temperature below the boiling point and is evaporated at some pressure above atmospheric. Heat must be added to bring the water to the boiling temperature corresponding to the boiler pressure and to furnish the heat of vaporization corresponding to that pressure. The quantity of heat must be found by referring to the steam tables. Let it be represented by Q. Now if the heat Q were used in evaporating water from and at 212 deg. F., the quantity thus evaporated would be $Q \div 970.4$, and this is the factor of evaporation. If it be multiplied by the water actually evaporated in a boiler, it will give the quantity that would have been evaporated "from and at 212 deg. F.," which is known as the "equivalent evaporation."

Ans. 8—The maximum indicated horsepower decreases with an increase in altitude. As the mechanical losses are the same regardless of the altitude, they are a greater percentage of the indicated power at a high altitude than at sea level. The brake-horsepower fuel consumption will then be higher at a high altitude. There are also other factors that influence the efficiency in the same direction.

Ans. 9—The allowable moisture in pulverizing coal depends upon whether the moisture is superficial or inherent. Superficial moisture is simply ordinary wetness, due to ground water or rain or snow, or the like. Experience indicates that it must be removed if the coal is to be pulverized successfully. Inherent moisture is built into the structure of the coal, as it were, in a manner analogous to the presence of water of crystallization in many substances. It appears that inherent moisture does not interfere with effective pulverization. Accordingly, some coals having high inherent moisture have been pulverized without difficulty with moisture contents that have proved impossible with coals of low inherent moisture. Lignite has been pulverized with 28 per cent moisture. Some bituminous coals cannot be pulverized unless they have been dried to 2 or 3 per cent moisture, while some can be pulverized even if they contain from 6 to 10 per cent moisture.

Ans. 10—A short circuit in the other field coil.

HEATING *and* VENTILATING

Exhaust Steam

Heats the Equitable Building

By JOSEPH WILLIAM DEGEN
Supervising Engineer

THE Equitable Office Building at 120 Broadway, New York City, covers a rectangular block of ground 48,862 sq.ft. in area. It is built as a solid rectangle from the street to the sixth floor. Above this the shape changes to an H, allowing two courts, one on Nassau Street and one on Broadway. The volume of the building above ground is 22,639,546 cu.ft. The height from the street to the roof is 542 ft. The floor of the sub-sub-basement, where the power plant is located, is 50 ft. below street level. There are 5,126 windows beneath each of which is a cast-iron steam radiator. The total direct radiation amounts to 157,000 square feet.

The tenancy of the building is exclusively of high-class office type, made up of brokers, insurance agents, bankers, lawyers and the executive offices of industrial concerns. The census of the building shows that approximately 12,000 people work in it.

An isolated power plant supplies all the electric current used for lighting and driving fan and elevator motors. Steam at 150 lb. per sq.in. pressure is furnished by four Heine water-tube boilers having a combined heating surface of 20,000 sq.ft. The generators are driven by Corliss engines. There are three 600-kw. units, two 300-kw. units and one 200-kw. unit. These are all direct-current generators supplying current to a three-wire system. The high voltage (240 v.) is for the power units, mainly elevator and fan motors, the low voltage (120 v.) is for the lighting and office electric accessories load. In the summer (or non-heating season) the engines exhaust to the atmosphere. During the heating season the engines exhaust at from one-quarter to one pound back pressure, supplying steam to a two-pipe vacuum-heating system.

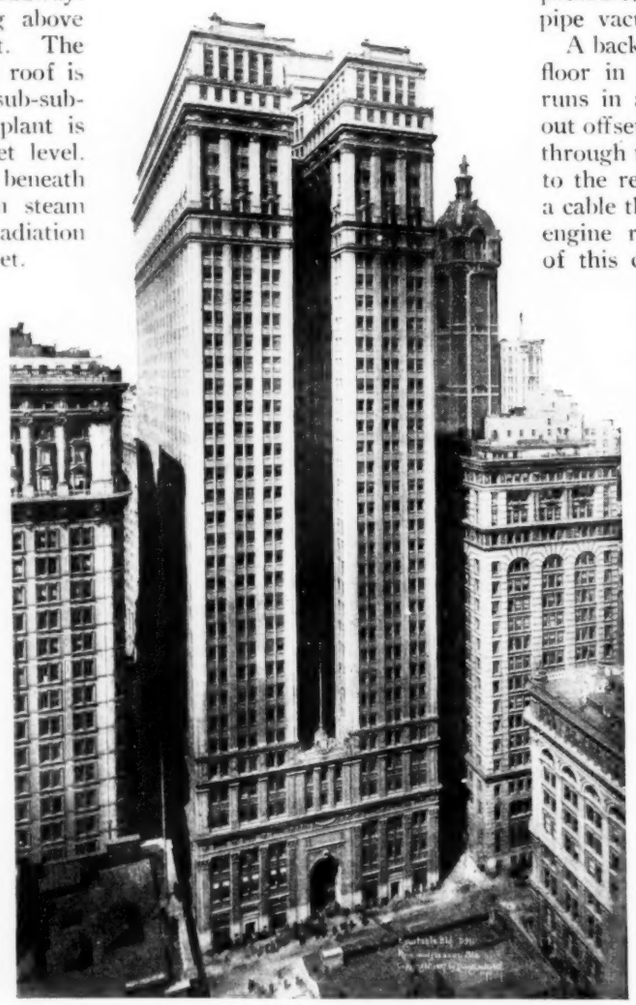


Fig. 1—The Equitable Building, Broadway, New York City

A back-pressure valve is at the 36th floor in a 30-in. exhaust stack that runs in a pipe shaft vertically without offsets from the sub-sub-basement through the penthouse roof. Attached to the regulating arm of the valve is a cable that runs free and clear to the engine room level. To the bottom of this cable are attached removable weights, the varying of which effects changes in the amount of back pressure. Close to the bottom of this cable are the indicating and recording gages showing the pressure and vacuum on the heating system, thus making it possible to ascertain readily the effect of changes in the weights.

The loss in economy of the engines, caused by the slight back pressure during the heating season, is what could rightfully be charged as steam cost against heating the building. A vacuum of from four to six inches makes for a positive flow of steam through the system with a good heat range.

From the curve, Fig. 2, showing a typical winter daily electrical load, it may be seen that the quantity of exhaust steam available for heating is very low un-

HEATING *and* VENTILATING

til 8 a.m. With the sudden influx of people into the building between 8 and 9:30 and the consequently increasing demand for lights and elevators, the electric load increases, thus making more exhaust steam available for heating. The reverse is the case at night, when between five and six o'clock the load drops off sharply, thus cutting down available heating steam. Because of this condition it is found necessary to use live steam early in the morning in order to warm the building by the time

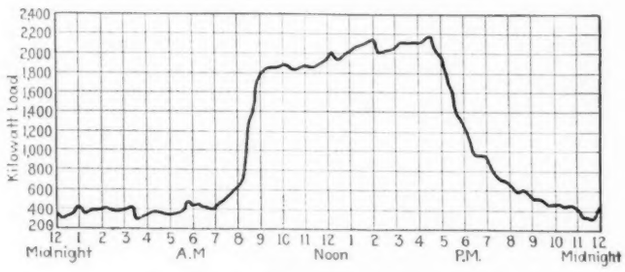


Fig. 2—Average daily load curve

the occupants arrive. The quantities and times when this procedure is followed will be given later under an explanation of the operation of the heating system.

There are three systems of piping for the heating system. The exhaust from the engines goes to an oil extractor or utility tank on the engine room level in the sub-sub-basement.

From here the main riser, previously described, carries the steam to the roof, a 24-in. branch being taken off below the back-pressure valve at the 36th floor. This branch divides into four loops, each valved, that carry steam around the periphery of one-quarter section of the building.

Risers from this loop feed up to the 37th, 38th, 39th, 40th and penthouse floors. Other risers feed down to the second floor.

A second tap-off from the utility tank carries steam to a loop in the hanging ceiling of the basement, which feeds up to the radiators on the first floor.

All riser branches and return lines are valved, so that, on holidays or Sundays, any one office can be heated with the exhaust steam available commensurate with the electric load on the engine working. These are all hand-operated valves, so that the engineer to heat an office on, say, the eighth floor, must send an assistant to the 36th floor to manipulate the section and riser valves. Diagram Fig. 3 shows the general arrangement of the heating piping.

A third tap-off carries steam to the heating coils in the ventilating systems for the first floor and basement. This is the only heating done under thermostatic control. All radiators in the offices are equipped with hand modulating valves.

There is a fourth tap-off from the utility tank taking steam to the hot-water heaters, which are operating all year.

Vacuum is maintained by three steam-driven vacuum pumps. An electrically driven Hytor is used to remove the air and water from the lines in the morning when starting up.

In the fall, with cool weather, the back-pressure valve on the riser is closed and the 24-in. valve to the heating system on the 36th floor is opened. The valves controlling the first-floor steam and the indirect system are also opened. With the moderate weather from the latter part of September until about the middle of November no live steam is needed, since the building holds a fairly even temperature overnight and week-ends. During this time, on days with a temperature above 53-55 deg. F., one vacuum pump takes care of the hot-water heaters and

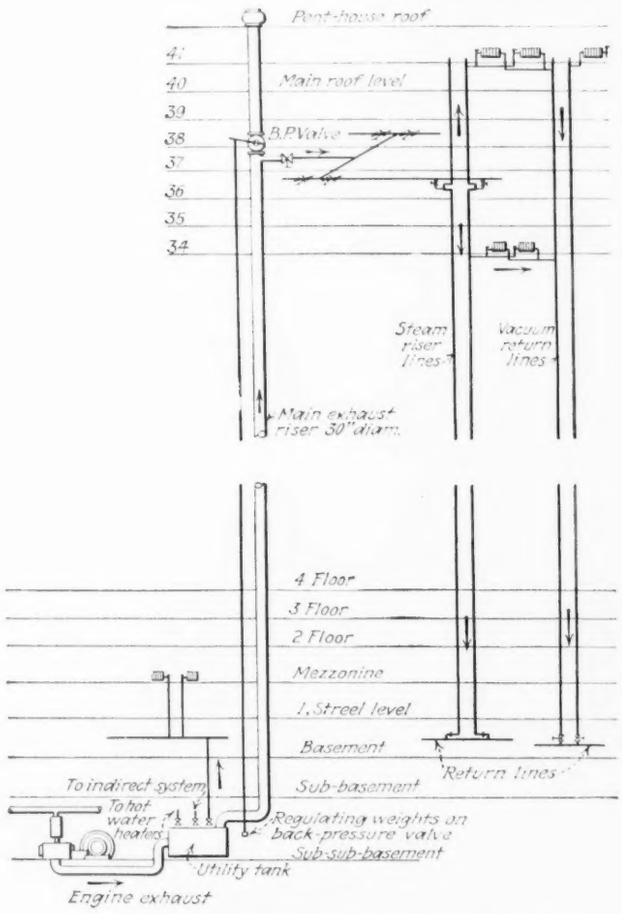


Fig. 3—Diagrammatic layout of heating piping

building heating system. With temperatures below that an extra pump is put on. The Hytor is used in the morning for about two hours, at the end of which time the vacuum pumps can take care of the small amount of air encountered.

About the middle of November the real heating season begins, and live steam is fed directly into the utility tank in the early morning only, through reducing valves. These are three in number and of 2-, 2½- and 3-in. diameter, all connected in parallel. The steam at 150 lb. per sq.in. pressure is reduced to 45 lb. by a "master" reducing

HEATING *and* VENTILATING

valve. The steam at 45 lb. pressure is regularly used by the two restaurants in the building and the building laundry. The steam for heating comes to the utility tank through this same valve before going to the valves in parallel, to be reduced to a pressure of two pounds per square inch. The quantity of live steam used to warm the building varies with the weather and occupancy conditions.

Live steam is necessary for early morning heating from about the middle of November until about the middle of April, depending, of course, on the severity and length of the season.

During the first and last months of the heating season live steam is not needed every day, but only intermittently, as the cold snaps of a day or two warrant it. During the middle of the winter the quantity used each day varies according to the weather, a sustained zero weather spell requiring live steam more regularly and at longer hours than varying more or less moderate weather.

During the heating season of 1925-26, 19,204,000 lb. of live steam was used as compared with 1926-27, when 14,200,000 lb. was used. The decrease was due mainly to a warmer winter and, secondly, profiting by experience, the engineers were better able to regulate the use of live steam while still obtaining satisfactory results.

From the middle of April until the weather becomes warm enough to turn off heat altogether, the exhaust from the engines alone is found sufficient to heat the building.

Operation of System

The engineer on watch from 12 o'clock midnight to 8 a.m. is held responsible for having the building warm, that is, at a temperature of 68 deg. To assist him in this, there are various indicating and recording instruments. A recording thermometer gives the outside temperature. The chart on this is changed at 8 a.m. daily, so that the engineer can see at 4 o'clock the next morning just how the temperature has varied in the previous twenty hours. A Caliscope, with twelve stations on the first and second floors of the building, gives temperatures at each of these twelve scattered stations at the time when the instrument is read. On the heating system are both indicating and recording vacuum and pressure gages. A recording and indicating steam meter on the live steam to the utility tank shows the rate of flow of the steam, the quantity used and the times of turning off and on.

The Caliscope readings are the indications that furnish the most positive evidence of results. Beginning at 2 a.m. the engineer records these temperatures on special report sheets at half-hourly intervals. He can then tell how much effect the steam is having on heating the building. The stations on the Caliscope are located on the two lowest floors, because with these floors warm, two things are known: First, that the steam has come down from the 36th floor through the heating system, and secondly, owing to the "chimney" effect of the structure, which induces an upward draft of cold air from the lower portions of the building, this cold air will be warmed, thus helping to heat the upper portion of the building.

In the event of complaints for heat the records from the engine room show whether the engineer has been lax in his duty, and also afford an opportunity to note the conditions so that future efforts may be more successful.

The standing order is "Have the building warm at 8 a.m. on all working days." To assist the engineer and also in the interest of economy, other orders are made operative to govern the procedure under certain set conditions. With the assistance of the records of past performances it is possible for the engineer to know whether to turn on live steam at 3 o'clock or 5 o'clock or at times in between. During the more severe portion of the heating season the first floor is kept warm at all times.

Maintaining a comfortable temperature on the first floor means more than keeping one floor warm—it means heating the air that filters in around the windows and doors on the lower floors, creating an upward draft in stair wells and elevator shafts. This air, if warm, aids in stabilizing the temperature of the upper floors, preventing them from becoming too cold to bring back to normal in a reasonable time, with economical use of steam.

Co-operation of Tenants Needed

The satisfaction of the system to the tenant depends, in part, on the tenant's co-operation in opening and closing the radiator valves to suit his own needs for heat. This is where the uncontrollable human element enters, and at times, owing to its variance, the building operating force is blamed for laxity in supplying heat. It has happened that on a moderate Saturday morning the tenants' employees have shut off the steam and been quite comfortable. With a drop in temperature over the week-end, due to a sudden storm and cold wave, these tenants' offices would ordinarily remain without heat until the arrival of the employees on Monday morning. By this time the walls and fixtures of the offices would be at such a low temperature as to act as "heat sponges" preventing the rooms from reaching a normal temperature for some hours. With this condition prevalent throughout the building, complaints would be many and severe.

To hasten the heating, fans would be taken from wall brackets and made to blow on the radiator, thus forcing very positive warm air circulation. A condition like this would be encountered probably only once or twice each year and then in only a minority of the offices, mainly in the lower floors of the building. In order to obviate this yearly "cold spell," the practice now is to have the night watchmen on their inspection rounds on Saturday and Sunday nights, turn on all radiators below the sixteenth floor. In this way the human element of the tenant is controlled over week-ends and on very cold nights.

As a general observation modern tall buildings are being equipped with incorrectly designed heating systems to the extent that, first, the upper floors are "over-radiated" and the lower floors "under-radiated," and second, the upfeed system does not extend high enough.

Consider a building 400 ft. tall. The desired inside temperature is 70 deg. F. The outside temperature varies through the year, heating and ventilating engineers usually taking zero weather as the basis on which to design the heating system. On a day with the outside weather at 20 deg., there would be a 50-deg. temperature

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difference between the air inside and that outside the building. That would mean a difference in pressure at the bottom between inside and out of 0.6 in. of water. This produces the "chimney effect" in tall buildings. Equalization of this pressure difference is of course prevented owing to the absence of a free air passage.

However, there are innumerable crevices and openings around windows, as well as periodic opening and closing of windows for ventilation and doors for passage, which permit the induced infiltration of the cold outside air at the bottom of the building. This air is warmed and rises, escaping through upper windows, doors and stair well, elevator shaft and ventilating skylights. So, the upper exposed floors of a building rising above surrounding structures are subjected not only to a cold wind on the outside, but also to a very appreciable warm air current within. Radiation, designed without consideration of this internal indirect source of warmth has, obviously, an increment of surplus.

As an example of the practical results of this upward draft of warm air from the lower floors on cold days, the majority of calls for heat in the Equitable Office Building are from tenants below the fifteenth floor, and very seldom do they come from tenants above the twentieth floor. This condition prevails even though the bottom of the building, as a whole, be at a comfortable temperature.

With respect to the extension of the upfeed steam system, it follows that it would be decidedly more economical to be able to heat only the lower six or seven stories with steam over nights, Sundays and holidays, allowing the rising warmed air to heat the top floors, than to be forced to heat the whole structure from the top down. In order to accomplish this low-zone heating in the most practical manner, the upfeed system should be run from the basement to the sixth or seventh floor, instead of only to the first or second, as is the most general practice at present.

What Is Differential Vacuum Heating?

Principal Features, Operation, and Reason for Economy

WHILE vacuum systems have used negative pressures on the return lines as an aid in returning condensation and to rid the radiators quickly of condensation, there are many factors that alter when a negative pressure is allowed to pass the radiator valve and enter, not only the radiator, but the steam main as well.

The chief features of fixed differential operation may be summarized as follows:

The use, during mild weather, of a negative pressure throughout the system on both steam and return piping as well as in the radiators.

The use of a fixed differential between the steam and return lines at all times except in extreme weather.

The use of traps on the radiators that will function efficiently at all pressures from 25 lb. gage to 25 in. of vacuum.

Employment of vacuums as high as 25 in. to reduce temperatures in the radiators during the time when maximum heat delivery is unnecessary.

The advantages that have accompanied this method of operation are chiefly those resulting from temperature control throughout the building and the greater satisfaction secured by this means of heating over ordinary vacuum operation due to the elimination of "overheating" so common in big buildings during mild weather.

The difference in pressure and temperature between steam at 2 lb. gage and 25 in. of vacuum is sufficient to reduce the radiator heat emission over 50 per cent, when the increased volume of steam at high vacuum and the decreased efficiency of the radiator at lower temperatures are considered. Consequently, any method of operation that will give vacuums approximating 25 in. in the radiator, will exert an influence on the heat supplied at least to the extent noted.

Assuming an ordinary vacuum system that has been equipped with radiator traps that operate efficiently between 2 lb. gage and 25 in. of vacuum, a vacuum return pump that will also operate under the 25-in. limit, a differential controller that automatically causes the pump to carry 2 in. to 4 in. higher vacuum on the return line than exists in the steam line, we have the essential elements for differential operation.

In cases where steam is supplied direct from low-pressure heating boilers, the pump is started as soon as fire under the boiler is lighted and straightway pulls a vacuum on the return line; since all radiator traps are thermostatic in principle and the radiators at this time are cold, the vacuum not only extends into the radiator through the open trap, but even enters the steam line and ultimately reaches back to the boiler, where steam, as soon as it begins to form in the boiler, is generated under a partial vacuum and therefore heating results are secured in less time than if the steam had to be generated under a positive pressure such as occurs with the common vacuum heating installation. Under this partial vacuum the steam required to fill the system is less in weight, owing to its expanded condition, than would otherwise

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be the case, so that the boiler not only steams more quickly, but actually has less steam to produce in order to fill the system. Both of these items tend toward quicker heating up, but are not the most important advantages secured, being in a way, only incidental to the basic scheme.

It is a well-known fact that the average winter requirement for heat is only about 50 per cent of the extreme temperature demand; in fact, heating engineers have long realized that the maximum demand on a heating system will occur only for a total combined period of one to two weeks during the entire heating season. This means that during about 90 per cent to 95 per cent of the time the average heating system is carrying—or

Vacuum pump for differential vacuum heating system

should deliver—only about half its capacity. Some days this percentage will be higher and some days it will be lower, but the average is close to the figure given.

Therefore, if the heat delivery from the radiator can be reduced at will from 100 per cent down to less than 50 per cent of the maximum, it follows that a heat balance in the building can be maintained in all ordinary winter weather; in other words, the heat input can be regulated to suit the outside temperature demands and "overheating" is impossible when this balance is continuously maintained.

With this in mind it is not difficult to understand that in ordinary weather there can be developed a certain amount of vacuum to be carried on the heating system so that the heat input will exactly equal the heat losses within reasonable limits.

Now to obtain this desired degree of vacuum on the radiators day by day, it is only necessary to run the heating boiler fire so as to show the proper degree of vacuum on the steam gage, which vacuum is suitable for the particular outside temperature existing on that day. The vacuum pump automatically holds a vacuum at the pump and on the return line of, say, 4 in. to 6 in. less pressure, or, in other words, a vacuum 4 in. to 6 in. higher than exists in the steam line, whatever it may be. Thus circulation and prompt return of the condensation are assured.

Where high-pressure boilers are in use and the building heating steam is supplied through pressure reducing valves, it is only necessary to change the adjustment of the reducing valve or to throttle the steam by any other method so as to secure—largely by self-condensation—the desired degree of vacuum in the supply line to suit the heat demands at any particular time. The use of high-pressure steam through reducing valves also lends itself readily to the sectionalizing of the building; that is, one reducing valve may be used to supply all the radiation on the south side, one on the north side, and so on. This means that when the sun's heat is available on the south side, the vacuum can be raised to take advantage of the fact, and if a cold wind starts up on the west side, the vacuum can be lowered until 70 deg. F. is held on that side while the higher vacuums on the other three sides are still maintained. In this way temperature control on the entire building or on the desired sections of a building is obtainable.

The fuel economies that have been obtained where this method of operation is in use, seem out of all proportion to what might be expected; in fact, they are not so much due to the method itself as they are to the elimination of "overheating." It might be said that the fuel saving is a "byproduct" of the elimination of "overheating."

Where no temperature control is in use, the ordinary heating system is, on an average, 100 per cent too big for the heat demand. Consequently, if the heating system is run at full capacity, there will be developed an average of 100 per cent too much heat and the fuel consumption will be double what it should be to supply just the necessary amount of heat required to maintain 70 deg. F. in the building. As a matter of fact most heating systems are not operated at 100 per cent capacity during mild weather; many expedients are evolved to overcome this discrepancy of heat delivery and heat demand. Some of these consist of on-and-off control, and dropping the steam pressure to the lowest point where all radiators will be heated. In spite of this, "overheating" is the rule, and the occupants of most buildings will secure relief by opening the windows rather than by closing off the radiators. The extra heat then disappears through the window opening and comfortable temperatures are secured, but at the expense of a considerable amount of unnecessary fuel.

A fixed differential method of operation eliminates the open window when used in an intelligent manner and in accordance with the outside temperature demands. In this system only the amount of heat necessary to heat the building is supplied and every B.t.u. not required is conserved. Hence the saving in the fuel.

The foregoing statements are not only made as the result of theory, but are practically obtained by operating engineers where fixed differential has been adopted and in the same buildings where, previously, the complaints about the heating were numerous and irritating, it has proved possible not only to practically eliminate these complaints, but also to make radical savings in the fuel used.

ELECTRICAL
Operation and Maintenance

Hendley N. Blackmon[1] *Tells*

How to Operate Shunt Generators in Parallel

POWER plants usually have more than one generator. There are several reasons for laying out plants in this way. The service is not interrupted if one unit breaks down, and repairs can be made with less inconvenience. By starting and stopping the machines as the load comes on and goes off, each machine can be kept close to its most efficient load. Where the capacity of an existing plant must be increased, adding another machine is usually the only expedient considered.

Sometimes several generators are operated in the same plant without being electrically connected, each generator feeding its own load. But this is usually an awkward arrangement, and as a rule, if generators can be operated together on the same load, it is done.

Once several generators have been operated in parallel, there is usually no difficulty in continuing. The operating engineer may have something to puzzle over when a new generator is to be added to the plant he has been running for years, or perhaps he has several duplicate machines that parallel easily and is required to add to the family a newcomer of strange design.

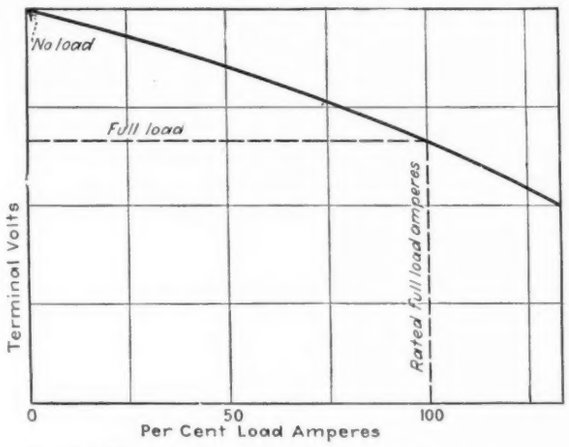

Fig. 1—Typical voltage curve of shunt generator

There is a fundamental law as to the parallel operation of direct-current generators. Each generator in parallel must try "to pass the buck" to the other units on the busbars. With each machine tending to shift load to the others in operation, no generator will take more than its share and stable conditions result. To obtain this effect, each generator must have a drooping voltage curve at the point where it is connected to the others; that is, the voltage of the machine must decrease as the load increases. It does not make any difference whether this reduction of voltage is due to the electrical character of the generator alone or to decreasing speed of the engine that drives it. In the following discussion the voltage curves mentioned always take into consideration whatever drop of speed there may be in the engine or other prime mover.

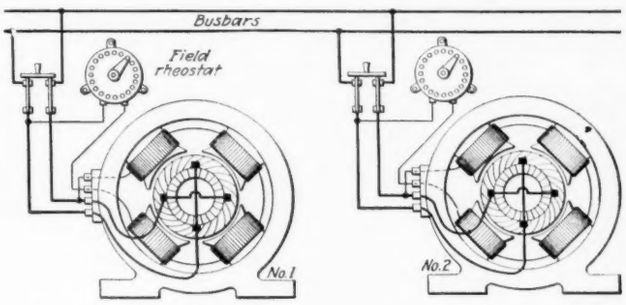

Fig. 2—Diagram of two shunt generators connected in parallel

The conditions to be met are the connection of shunt machines together and compound machines together. Compound and shunt machines are not ordinarily operated together. Occasionally, separately excited machines are encountered, but this is not frequent in direct-current practice.

Shunt generators inherently have voltage regulation curves adaptable for parallel operation; that is, the armature naturally gives a drooping voltage characteristic as in Fig. 1. At no load the voltage is considerably higher than it is at full load. The droop in the regulation curve is due to the following causes:

1. The volts drop through the armature windings increases as load increases and is equal to the product of the armature's resistance in ohms and the load current in amperes.

2. The steady decrease of useful flux in the field poles

[1]General Engineer, Westinghouse Electric & Manufacturing Company.

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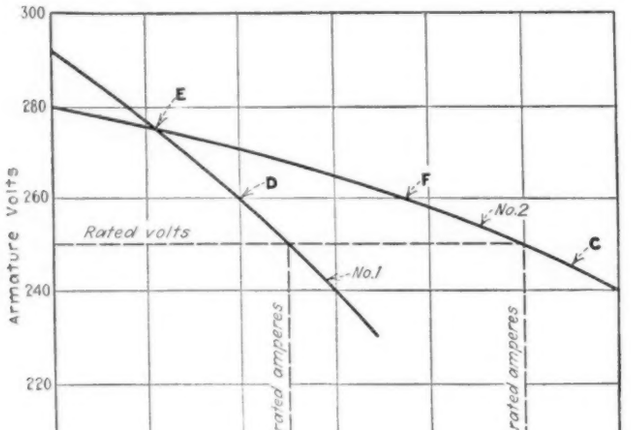

Fig. 3—Voltage curves of two shunt generators

as the load increases, due to armature reaction; that is, the magnetic effect of the armature distorts and weakens the magnetism of the field.

3. The reduction in voltage caused by 1 and 2, lowers the shunt-field exciting current. This further decreases the terminal voltage of the generator.

The decline of voltage, as the load increases, insures equilibrium of two machines operating in parallel. In Fig. 2 it is assumed that generator No. 1 is rated at 500 amperes at 250 volts and machine No. 2 normally operates at 1,000 amperes at 250 volts. The voltage characteristics of these machines are assumed to be as shown in Fig. 3. The total load is 1,500 amperes when each machine is operating at 250 volts and delivering its normal output.

Assume the prime mover of No. 2 machine momentarily increases in speed. With the total load remaining fixed at 1,500 amperes, for an instant No. 2 machine will tend to carry, say, 1,100 amperes. This load, however, corresponds to about 243 volts, as at point *C*, instead of 250. If unit No. 2 supplies 1,100 amperes, the output from generator No. 1 is reduced from 500 to 400 amperes. This load tends to operate at 260 volts, point *D*, instead of 250. Since generator No. 1 has a momentary high voltage, it will tend to assume more load and unit No. 2 operating with low voltage will drop part of its load. Thus the units tend to redivide the total output again in the ratio of 1,000 amperes and 500 amperes, respectively. With shunt generators the reactions of the system are such as to hold the generators in equilibrium.

By properly adjusting the shunt-field rheostats of the two machines the voltage curves are shifted up or down until the two machines each carry rated load. This is the condition represented by the 250-volt ordinate in Fig. 3, each machine being 100 per cent loaded.

Assume the total load is decreased to 1,100 amperes. The voltage rises to about 260 and generator No. 1 will supply about 400 amperes, while unit No. 2 will furnish about 700 amperes. The per cent loading of the two machines is changed. Machine No. 1 is now working at 80 per cent capacity (400 × 100) ÷ 500, and generator No. 2 is operating at 70 per cent capacity (700 × 100) ÷ 1,000. This condition continues to become worse as the load is further reduced.

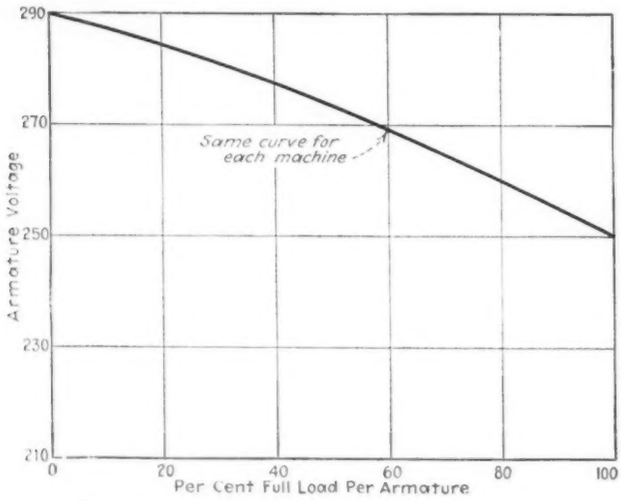

Fig. 4—Regulation curves plotted in terms of per cent load

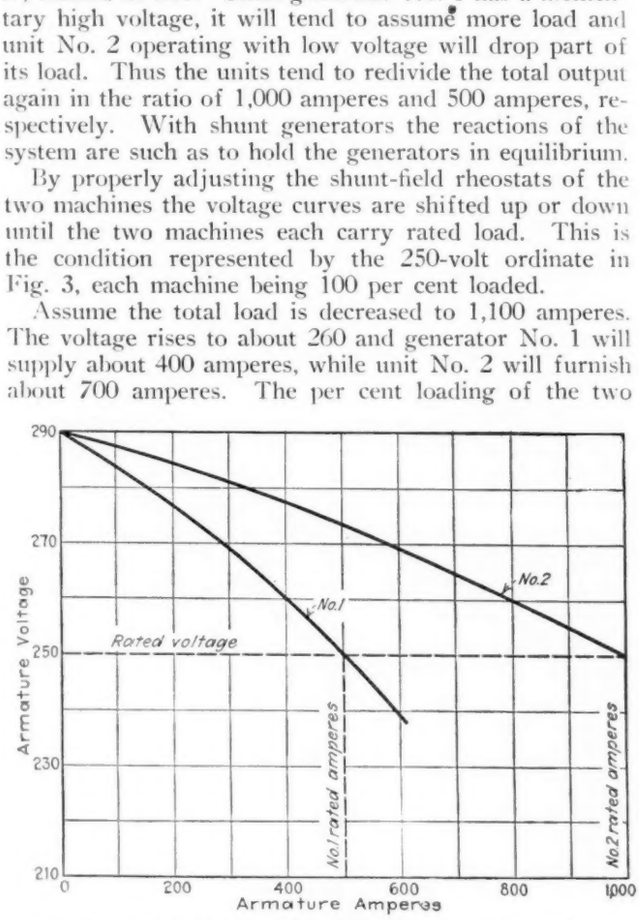

Fig. 5—Load divides in proportion to rating of two generators if the regulation curves are similar

The fields of the generators may be adjusted to give any desired division of amperes at one single load, but for all other loads the ratio of per cent loading will not be maintained. Machines in attended stations usually operate in this manner without trouble. At any demand below full load the per cent loading will be unequal, but neither generator will be overloaded.

A consideration of Fig. 3 shows that without load, if the shunt-field rheostats were not altered, generator No. 1 would tend to generate about 290 volts and generator No. 2 280 volts only, therefore, No. 1 would cause unit No. 2 to run as a motor. If the motoring effect is not too great, this action is of small consequence, since the motor torque produced in unit No. 2 is such

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as to rotate the armature in the same direction as turned by the prime mover. However, stations usually have attendants; and when the load demand is sufficiently reduced, one unit is removed from the busbars. For this reason both machines are rarely on the system when the load decreases past the intersection point E on the two curves. The foregoing statements refer primarily to stations supplying load that is not of a fluctuating nature. Railway and steel-mill demands often swing to zero and reverse current is of consequence, since the protective device must be set to operate on idling current in case of alternating-current power failure.

The generators, however, will share their load correctly at all times if the regulation characteristics are identical when plotted in terms of per cent full load, as indicated in Fig. 4. It is assumed that the design and adjustments of machines No. 1 and 2 are such as to result in the characteristics given by Fig. 5. As before, machine No. 1 operates at rated load of 500 amperes and unit No. 2 carries its rated load of 1,000 amperes, each delivering 100 per cent capacity. If the external demand is reduced to 900 amperes, unit No. 1 produces 300 and generator No. 2 delivers 600, each generator is loaded 60 per cent. Therefore, curves plotted in per cent load for each machine will be identical and the machines, in addition to maintaining stability, at all times will share their respective load in exactly the correct proportion.

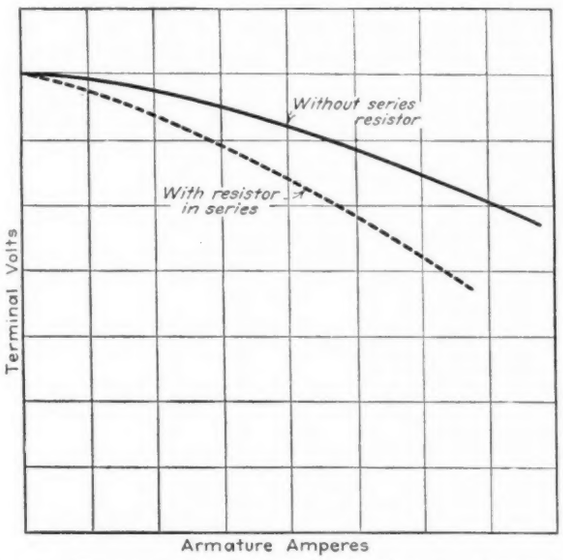

Fig. 6—Shows how voltage regulation is changed by connecting resistance in generator's armature circuit

This condition is more difficult to obtain in the case of machines of different types and ratings. For example, the droop in an uncompensated unit is much greater than in a compensated machine and the shape of the curve is quite different. Usually, the characteristics may be adjusted to bring the discrepancy within practical limits. The characeristic of the better machine may be drooped more by placing a series resistance R in the armature circuit, as in Fig. 7. This action is at the expense of economical operation. The curves, Fig. 6, show the voltage of the generator with and without series resistance. The more drooping the characteristics the more stable will be the parallel operation of the machines. Duplicate shunt machines, although necessarily having minor differences in their voltage characteristics due to manufacturing variations, will ordinarily operate excellently in parallel because of the large droop. The following summary applies to shunt generators in general:

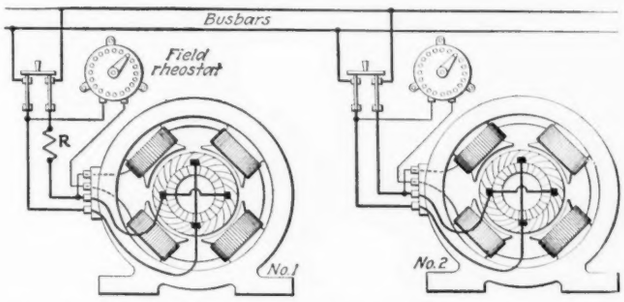

Fig. 7—Voltage regulation curve of generator can be changed by connecting in a resistance as at R

1. Any two shunt generators will operate in parallel if properly adjusted and will remain in stable adjustment.

2. Shunt generators ordinarily operate satisfactorily, with regard to division of load, unless the two voltage regulation curves are greatly dissimilar.

How Oil Was Prevented from Getting Into Generator Windings

By R. C. Laney

WE ARE operating a number of gas-engine-driven generators in our power stations. These engines are the horizontal twin-tandem type with the generator rotor keyed to the crankshaft. The general arrangement is shown in Fig. 1.

The oil in the gear cases on either side of the engine has a tendency to travel along the shaft and get in the generator winding, where it causes the insulation to deteriorate rapidly and break down. This condition necessitates rewinding the stator, and considerable lost time results.

To eliminate this trouble several devices were tried with varying success. About two months ago the chief engineer conceived the idea of placing two straight guides parallel to each other on the outside of the gear case with a ring of packing running between the guides. With this idea in mind I made the oil deflector shown in Fig. 2.

To keep down the weight of the guides, they were made of $\frac{1}{4}$-in. fiber board, because the crankshafts were $30\frac{1}{2}$ in. in diameter. These guides were cut into three sections each to save material. The joints between the sections were dovetailed, as in Fig. 2 *A*, to make the rings more rigid and hold the sections in a true circle

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while laying out and drilling the holes for the bolts. A piece of $\frac{3}{8}$-in. pipe was cut into sections $\frac{5}{8}$ in. long to be used as spacers and keep the guides parallel and $\frac{5}{8}$ in. apart, Fig. 2 *C*.

The first guide was assembled in place and a piece of $\frac{1}{2}$-in. packing was cut to fit snugly around the shaft. The ends of the packing were fastened together with a hoop

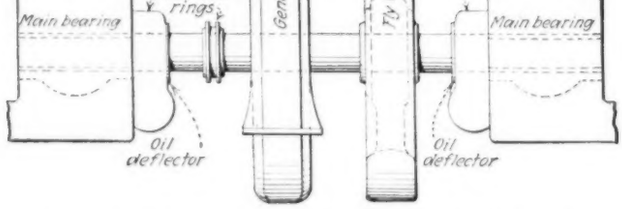


Fig. 1—General arrangement of oil-engine unit

staple. A garter spring was put on over the ring of packing to hold it tight to the shaft. This spring would not stay in the center of the packing ring and would wedge down between the ring and the guide. There were several sets of old metallic packing in the toolroom, with keepers to hold the springs in place. These keepers were not the same diameter as the outside of the packing ring when on the shaft, but that did not make any difference because I broke the keepers into pieces about $2\frac{1}{2}$ in. long. This made the difference in curvature negligible. The ends of these keepers were rounded to keep them from catching on the sides of the guides and spaced equally around the ring of packing. The outside guide was then

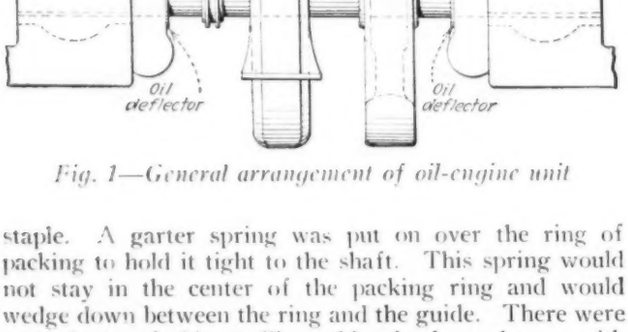


Fig. 2—Construction of oil deflector

assembled on the shaft and both guides bolted to the gear case with the $\frac{5}{8}$-in. spacers between them.

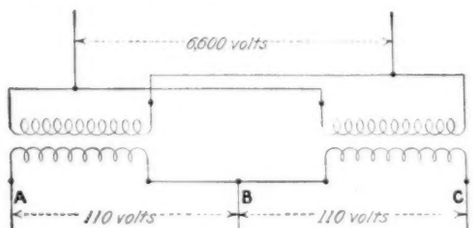
The results have been satisfactory. Two of these deflectors have been in continuous service since they were installed two months ago. There is no oil on the crankshafts, and the generator windings are drying out. This type of oil deflector may be used on shafts of any size by varying the dimensions of the different parts. The guides can be made in two parts for small shafts and the material may be metal if desired.

Potential Transformer Caused Synchronizing Trouble

By G. Richter

OUR new hydro-electric plant had been in operation for about six months when it was shut down for inspection. All the equipment was found in good condition except one governor and a potential transformer. The latter was used for synchronizing one of the machines. After the governor had been put into condition and the defective transformer replaced by a new one from the storeroom, one of the hydro-electric units was started and synchronized with the steam station on the system.

When the second unit was synchronized and connected to the system, its oil switch immediately tripped out. This was tried a number of times; each time the synchronizing lamps showed the correct phase relation, but each time the oil switch tripped out as soon as it was closed. All the connections were examined and found to be as they were originally before the transformer was



Connections for testing transformer polarity

changed, and the machine operated satisfactorily in every way except when the oil switch was closed.

It was then decided that the trouble must be with the new potential transformer. This was disconnected for testing to see if it was defective. One of the first tests made was for polarity. The new transformer was connected in parallel with the old one as indicated in the figure, and a test was made on the low-voltage side with a voltmeter.

When readings were taken between leads *A* and *B*, a reading of 110 volts was obtained, likewise when a reading was taken between leads *B* and *C*. When the voltmeter was connected between leads *A* and *C* its needle remained on zero. This showed that the polarity of the new transformer was opposite to that of the old one and the secondary voltage of one transformer opposed that of the other. If the polarity of both transformers had been the same, 220 volts should have been indicated by the voltmeter.

The new transformer was put into service again, but this time its low-voltage leads were crossed, and when the machine was synchronized it went into service without any further trouble. With the transformer as originally connected, the oil switch was closed with the machine 180 deg. out of phase. This little experience shows that all transformers should be tested for polarity before they are put into service.

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A Power-Factor Analogy

By Elmer S. Smail

WHEN speaking to the layman, the engineer can use the terms kilowatt and kilowatt-hour with confidence that they will be understood. Everybody knows that they are units of electrical energy which are measured on a meter similar to a gas meter and that the monthly domestic electric bill is rendered on the basis of the kilowatt-hours used.

Unfortunately, it is sometimes necessary for the engineer to use the terms kilovolt-ampere and power factor, and right there, whether the engineer realizes it or not, the layman loses contact. If anyone doubts it, let him stand by and watch the non-technical plant executive when a sales engineer is trying to sell him a static or synchronous condenser. Another example is a power representative trying to explain to a customer why his bill is higher this month because of a penalty for low power factor even though the kilowatt-hours used are no greater than last month.

The engineer frequently makes conditions worse by going into a technical explanation introducing angles of lag, wattless current, etc., all unintelligible to the prospect. I have found the best method when explaining this condition is to use the following analogy:

A dealer in hay owns ten freight cars in which he can do his shipping. Each car will hold 2,000 cu.ft. and is strong enough to carry 100,000 lb. He has one customer who requires 400,000 lb. of hay per month and orders this hay unbaled. Suppose in this loose condition hay weighs twenty lb. per cubic foot. Each car will hold 40,000 lb. and it will require the services of all ten cars to make the shipment.

Another customer requires 400,000 lb., but will accept the hay compressed to the point where it weighs 40 lb. per cubic foot. This shipment will require only five cars. Still another customer contracts for the same weight, but permits the hay to be compressed to 50 lb. per cubic foot, assumed to be the maximum compression possible. This shipment can be taken care of in only four cars.

The weight of hay is the same in each instance, but in the first case the shipper ties up ten cars, rendering him unable to serve any other customers. In the second case he ties up five cars and can handle additional business with his equipment. The third case is even better, and he can ask for nothing better, as each car is loaded to its maximum permitted weight.

We might express the ratio of pay load as a percentage, in which case the third condition would be 100 per cent pay factor, the second 80 per cent, and the first only 20 per cent. No one would blame the dealer for charging a higher rate for hay when the pay factor of a shipment was low.

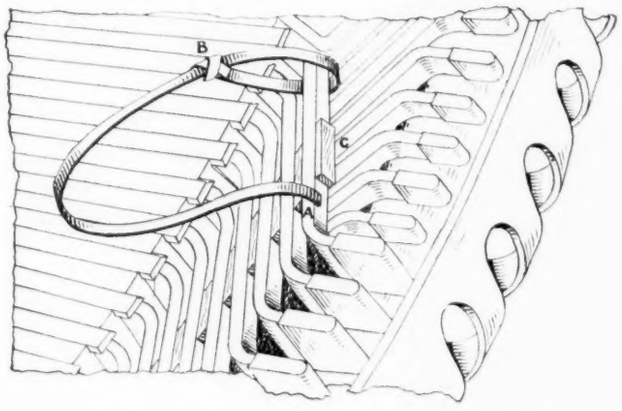
The freight cars correspond to the generators in the power plant, the pounds of hay to the kilowatts and the volume of hay to the kilovolt-amperes. For pay factor substitute power factor and for wear and tear on rolling stock substitute transmission line loss. By carrying the analogy a step farther, we can represent a synchronous condenser for power factor correction by a compressing machine owned by the customer. It takes a little power to transport it along with the hay, but it pays its way by making the space requirements less.

Making a Good Job in a Difficult Place

By J. H. Boffy

ON A 13,000-volt 4,400-kva. waterwheel-driven generator the stator coil ends were kept apart by small wooden blocks. These blocks were taped and varnished when the winding was put in place. Cleaning the end windings gradually wears the tape off, and the blocks become loose and fall out.

To retape the blocks in position looked to be a difficult job, for it was impossible to get both hands down to the



Shows the tape ready to be put on one coil

work. I could get one hand down and the other only part way on account of the shape of the generator end covers and the rotor end. With $\frac{1}{4}$-in. clearance on each side of the coil and not that much on the bottom, the job of fishing every lap of tape around the coil would take a considerable time. There were about ten laps of tape on every block and as only one hand could be used to do the work, I conceived the following method:

The tape was cut the required length to make ten laps and leave enough to make a loop around the coil as shown at *B* in the diagram. With this method the only time the tape had to be fished around the coil was to make the loop. The knot was tied with a bowline to prevent it from slipping. The other end of the tape was made fast at *A*, where the binding started, by sticking it with a spot of shellac. By pulling the loop around the coil the tape was wound on, and by see-sawing each turn into position I was able to make a neat job quickly. In the diagram one of the wood blocks is shown at *C*.

By keeping the tape flat it was easy to slide each turn into position under the coil. After the binding was completed, it was shellacked and varnished, which made a neat job, and the spacing blocks were held securely. This method certainly took the meanness out of that job for me, and I hope it will for others.

EDITORIALS

Confidence and Co-operation

WHAT are the factors in American industry that make possible the present unprecedented prosperity, in which one of the most pressing problems of industrial plants is the provision of parking space for employees' motor cars? Certainly, nothing in the past history of industry explains such a condition, for in America of the past, as in Europe today, the industrial worker usually earned barely enough to keep him in decency and no margin existed for such luxuries as automobiles, even had they been available.

The factors are manifold, that have acted to bring about this change. Collectively, they are known as "consumptionism" and comprise such elements as the unrestricted production of goods and a correspondingly unrestricted consumption. But, elsewhere at present, and in this country in the past, production has not been unrestricted, and consequently, consumption has had to be limited, an end unfortunately achieved by keeping wages down to a bare subsistence level. There must be some factors now active in American life that have broken the bonds of production and, consequently, made both possible and necessary the increased consumption of goods and services that marks our present prosperity.

These new reagents of industry are confidence and co-operation—confidence of workers in management, of management in workers, and of both in capital. Confidence has made possible a use of power and machinery in this country that is not elsewhere duplicated, that is, in fact, fought against by the workers of other countries. Confidence has made possible the increased remuneration of workers, so that they can take their place as larger consumers of the products that they and others make. Confidence, finally, has wiped out the unjustified suspicion of capital, which in the past has handicapped industry, and has at last freed capital so that, built up as it is of the savings of all, it can bring to all a full return.

And from this mutual confidence among capital, labor and management, three groups which are now becoming coincidental, has sprung real, effective co-operation. Without such co-operation the best team becomes merely a group of stars, whose best efforts, no matter how individually brilliant, get but small results. And it is so with industry.

But when men, with full confidence in one another, co-operate to the fullest extent, the limit to the results achievable cannot yet be predicted. Certainly, with the imperfect co-operation so far achieved in America, the increase in prosperity has been great. What the future holds in store should be even greater. But it will not be, unless labor, management and capital all strive to preserve and justify that confidence upon which, alone, effective co-operation can be based.

Simplification and Standardization

COMMENTING upon the recent editorial in *Power* on "Practices Leading to Small Profits," one prominent manufacturer suggests simplification and standardization as the solution of the problem. Engineers, in general, he finds unwilling to admit that the manufacturer knows enough to make his product right. The result is the incorporation of many special and personal ideas into the design of equipment.

This viewpoint will undoubtedly find confirmation among many manufacturers, who have experienced too much individualism among certain engineers.

In commenting upon this independence of the individual engineer, a prominent member of the profession recently remarked that engineering is an exact science—each engineer insists on doing exactly as he d——n pleases. It is fair to ask whether this independence always represents good economics.

Some justification from the engineer's point of view exists in the rapid changes and developments now going on in power plant practice in the quest for greater economies, also from the fact that the purchaser presumably knows intimately his local conditions and requirements. On the other hand, the manufacturer presumably knows what his equipment will do, and he has been privileged to observe its performance under various conditions in other plants. This should carry weight with the user. The manufacturer also knows something about the results that may reasonably be expected from modifications of his product. Doubtless he has tried some of them to his sorrow.

That power plant design is at present in a nebulous state, accompanied by utter lack of standardization, is evident to anyone familiar with modern stations. How long this will continue in view of the ever-diminishing margin of possible savings is a matter of conjecture. Special designs are expensive, and it is conceivable that, after some of the practices now being tried out have

further crystallized, power engineers will look to reduction of fixed charges through standardization and simplification as the means toward further economies. Meanwhile much can be done toward acceptance of standardized designs in those parts of the station that are not affected by present experimentation.

Too much specialization in design means high cost to the purchaser and usually small profits to the manufacturer—an undesirable condition that is often not warranted by the ends attained.

Is the Plant Switching Equipment Adequate?

INCREASING the number of generators, transformers, motors and feeders in a power system may lead to conditions that will make the original switching equipment and busbar structures inadequate. This condition may exist until some emergency arises that will develop into a failure and cause a complete shut down.

Many industrial power plants have grown from comparatively small beginnings to where thousands of kilowatts are connected into one system. The current that can be fed into a fault by the enlarged system may be many times that which could occur with the original layout. Investigations of one industrial plant power system showed that short-circuit currents of sixty thousand amperes could be obtained on its 6,600-volt system. On account of the proximity of faults to the generators on the industrial plant system, short-circuit currents may be comparable with those on central station systems.

It is not generally appreciated that switching equipment that is adequate to handle short circuits on a small system may be entirely unsuited for a larger system. The normal requirements may be the same in both cases, but in the large systems the emergency requirements may be many times those for the smaller system.

Unless the system is properly constructed, the heavy currents will set up forces that will displace cables, break busbar supports, cause oil switches to fail, force disconnect switches open unless they are locked closed, distort windings in generators and produce expensive failures of the plant. In many of the old plants the switch and busbar construction is such that if an oil switch or disconnect switch fails, the arc is likely to be carried into the busbar and cable structures and cause a short circuit of the whole plant. Such happenings, experience has shown, may cause serious damage by magnetic forces wrecking equipment, and by fire.

Before these things have happened the fault should be corrected. What the likely values of short-circuit currents in a system are can be calculated. In every system where there are any doubts as to what the conditions are, they should be determined, and if weak spots are found in the equipment, corrections should be made before a failure occurs. A large electric system improperly protected is much like dynamite—it looks all right until something happens to start it going, then all that can be done is to pick up the wreckage and repair the damage. Because the equipment looks right and has never given trouble, may be a false security that will lead to a shutdown and a large repair bill. It is necessary to go deeper than outside appearances in electrical equipment to insure against unexpected failures.

Imagine the Savings!

IMAGINE what a difference it would make in the total amount of process steam used at some plants if the various departments could be checked up on their use of this steam and the department heads paid a bonus, depending upon which of them operated the most economically. Such a procedure would set up a spirit of healthy rivalry that could not fail to result in economies in the amount of steam used, with a corresponding reduction in the cost of the products of the plant. In fact, one plant that did this changed a liability-product into a money-maker.

But checking up on the steam consumption would require the installation of some flow meters. Also, someone would have to spend some time and thought on the matter. If the power engineer took the lead in this matter, it would, of course, improve plant conditions with reference to the services that he supplies. But the necessary time and money expenditure might have to be authorized by the management, and that might present difficulties.

And the management, being impelled by competition to keep manufacturing costs down, is not interested in how much steam is wasted. Oh, no! But, if they were, and had this "check-up and bonus" system installed, imagine the savings that could be made!

IN A CONTRIBUTION to the "Annual Survey" of the *New York Evening Post* on conditions in the electric utility field, H. T. Sands, president of the National Electric Light Association, reports a new high mark of more than seventy-nine billion kilowatt-hours sold during 1927. This is an increase of seven and one-half per cent over last year. Moreover, the ever-increasing output has been accompanied by a decreasing average cost of electricity to the consumer, which is now at a figure somewhat less than pre-war levels, although the general index in the cost of living has increased sixty-five per cent during the intervening period. This condition has been made possible largely through greater economies in production accompanied by increased load factors. It is a striking testimonial to private initiative and the American way of doing things on a progressive scale, a work in which the engineer has played an important rôle.

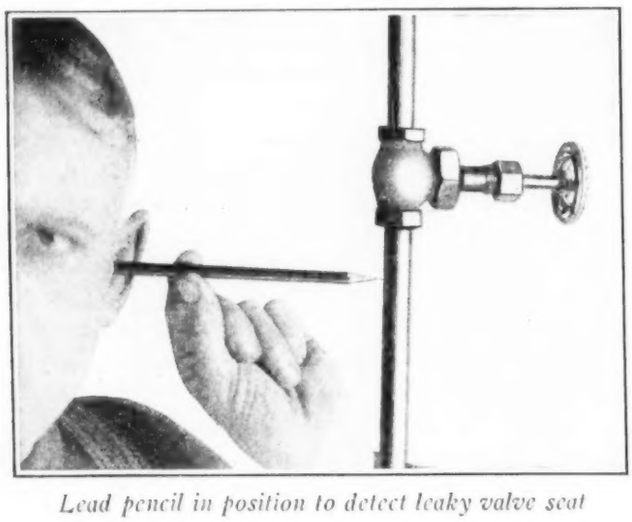
IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Lead Pencil Is Excellent Detector for Leaky Valve Seats

THE ordinary lead pencil is an excellent detector, if not as good as the best, in makeshift means of determining leaky valve seats and running down mysterious pounds.

The unsharpened end of the pencil (no rubber end) should be held snugly but not too firmly in the ear. Rest



Lead pencil in position to detect leaky valve seat

the lead or point on the part under test. The lead center is an excellent conductor of the least bit of sound and is a simple but efficient means of running down many of those puzzling noises that indicate trouble. Try it next time. F. BENJAMIN.

Missouri Valley, Iowa.

Practical Pipe Repair

A SMALL manufacturing plant obtained its water supply through a 4-in. pipe which entered the premises through a solid concrete foundation wall. One night the pipe developed a leak, and it was found to have split in the weld for about eight inches, beginning at a point about two inches from the wall.

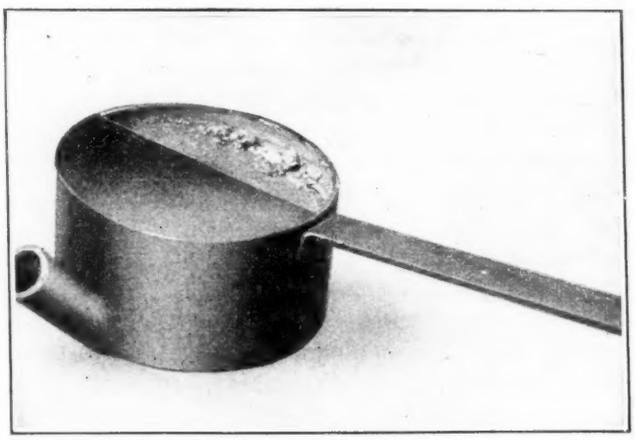
After a study of the conditions the engineer decided it would be inadvisable to repair the pipe by cutting it and rethreading the section in the wall, as the pipe might not stand up under the stress of the threading die. As it was possible to uncouple the end of the projecting pipe, this was done, and a sleeve 12 in. long, cut from a piece of 6-in. pipe, was slipped over the leak and supported temporarily in position by three short rods of such diameter as approximately to center the sleeve on the pipe. A special calking tool was then made, and the space between the pipe and sleeve was calked tight with lead wool, the rods being removed when sufficient lead had been put in to hold the sleeve in place. This made a practical and satisfactory repair. J. F. HOBART.

Indianapolis, Ind.

Pouring Babbitt From the Bottom of the Ladle

THE scum or other foreign matter that collects on the top of melted babbitt has to be skimmed off repeatedly to avoid pouring it into the work. In spite of all the skimming, however, it often happens that a small piece of coke or other solid piece floating on top of the babbitt escapes notice and finds its way into a bearing.

To avoid this, I made the ladle shown in the illustration, in which the babbitt is poured from the bottom, where it is always clean.



Spout leading from the bottom of the ladle assures clean babbitt

For the ladle I used an old vessel with a spout leading from the bottom. I cut off the original handle, which was on the opposite side to the spout, and welded a new handle at the side.

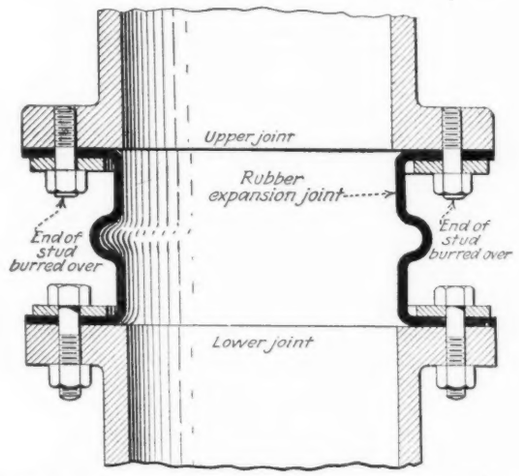
Since all impurities found in melted babbitt are floating at the top, this ladle gives a clean flow of metal from the bottom. A. KENDALL.

Hamilton, Ont., Canada.

Changes to Facilitate Removal of Expansion Joint

BETWEEN the hotwell and the condenser serving a 10,000-kw. turbine-generator in our generating station, are three rubber expansion joints of 20 in. diameter each. It has been found necessary at times to remove these joints.

Holding the lower flange of the expansion joint to the flange of the hotwell are standard bolts and nuts



Stud and nuts used in upper joints were made into capscrews by peening over the ends of the studs

which can be easily taken out. The upper flange of the expansion joint, however, is attached directly to the body of the hotwell by stud bolts and nuts $1\frac{1}{4}$ in. in diameter. Before the expansion joints can be taken out of position, it is necessary to remove the studs entirely, because it is impossible to spring the expansion joints sufficiently to clear the ends of the stud bolts. It is difficult to remove the studs because of the constricted space, and some of the threads on them were damaged in taking them out.

After performing this operation, it occurred to us that the studs could readily be converted into capscrews by heating the end of the stud and nut and then peening over the end of the stud bolt until the nut was permanently attached to it. After converting the studs into capscrews, we found that the work of removing and replacing the expansion joints was greatly simplified.

Holtwood, Pa. P. E. STRICKLER.

Effects of Air Leaks on Condenser Auxiliaries

SOME time ago the question, "What causes high water in the glass of a condenser?" was asked an applicant for an engineers' certificate.

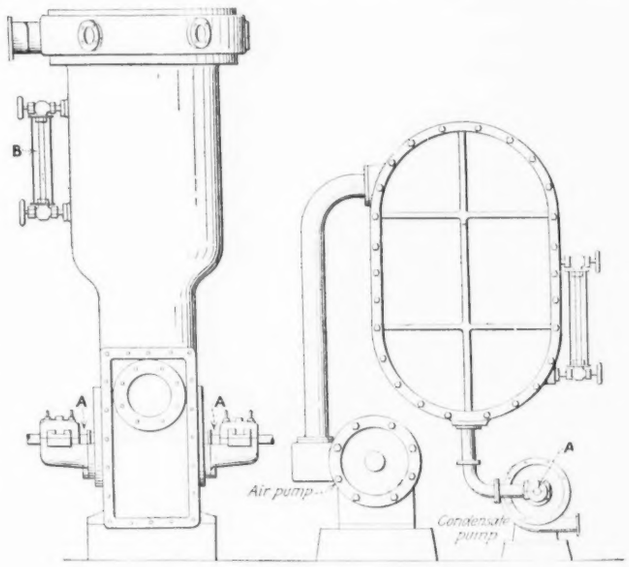
It was easy for the applicant to answer, "Because the pump is not removing the water fast enough." This did not satisfy the examiner and the applicant was refused a certificate. Probably the applicant answered several questions in a similar manner. But to get back to the original question. Without doubt the area of highest vacuum will be at the point where the vacuum is produced. In a low-level jet condenser, leaky stuffing boxes as at *A-A* in the illustration will cause a flow of air through the water column toward the condenser proper, reducing the weight of water and causing a rise in the glass and more or less air bubbles. If possible to speed up the pump, as, for instance, in the case of a turbine-driven unit, this leakage may be overcome to some extent.

Trouble with gland seal through clogging of the small apertures might cause the leakage. Of course the proper procedure is to flood the boxes from an outside source until necessary repairs can be made.

In the case of a surface condenser leakage at the condensate-pump stuffing boxes will give the same result.

Some few years ago in a moderate-sized plant, one engine lost its vacuum every morning in the week regularly at about seven o'clock. This engine was served with a surface condenser, and the condenser, in turn, was served by a steam-driven, variable-speed reciprocating dry air pump. No trouble was experienced during the night run, but for one hour in the morning the vacuum would fluctuate up and down. This condition had prevailed for several months—probably over a year—when a new chief engineer came on the job. The third day the new chief was on the job, he discovered the cause of the condenser trouble.

He found his assistant screwing the governor down for more speed on the dry pump. At night the vacuum was lowered, as the load was light, but the first thing



Arrangement of jet and surface condenser with auxiliaries

in the morning, when the assistant came on duty, he proceeded to speed up the dry pump, creating a higher vacuum in the condenser than the condensate pump was designed to operate against, there being very little head on the condensate pump, owing to a shallow basement, so the water would rise in the condenser and put it out of business.

This condition had obtained for several months, and, as I have already stated, was stopped more or less accidentally. C. W. PETERS.

New York City.

COMMENTS *from* READERS

What Would You Do?

WITH reference to the article, "What Would You Do?" in the June 28, 1927, issue of *Power*, what I should like to know is what am I eventually going to do?

I see where some engineers have adapted themselves to other conditions and other jobs to get along. I first went in the power game in the marine service in 1918, following it for four years, then went ashore, and secured a job as chief engineer of a steam-electric plant. I held this position till a year and a half ago, when I started in electrical construction and maintenance work, continuing to look after the plant whenever necessary. Some time later the plants here were all changed to purchased power, owing to a merger of companies buying power cheaply in the block. Thousands of dollars worth of first-class generating equipment was shut down and sold at any price that could be obtained.

The owners of the small plants were not interested in power, but in the production of their product and the over-all cost. The power plants suffered for the want of proper instruments to insure economical and reliable operation and the employment of properly trained men to insure this operation. The method of figuring the cost of the power plant was to get as near as possible the kilowatts generated per month and divide this by the total cost of labor, maintenance, depreciation, equipment purchased and fuel purchased, not comparing this with production. The cost of the plant was what worried them most, not what became of the energy generated.

Two of these plants were nearly new, but when the power company came along with a flowery tale, the owners fell for it and shut them down. We ran tests on two of them just before the shutdown, and for their size they were quite efficient. I helped change some of these plants over, and also helped rewire several of the mills. Upon completion of this work I was put in charge of a maintenance job, where I possibly would have remained for years to come even though the opportunity of advancing or learning would be negligible.

All this time I have spent money trying to educate myself for advancement and be more valuable to my employer. In this last job a strong back was the principal requirement, so I got out. However, I am determined to get back into the power game again if I have to start as a fireman, and also try my luck in another section of the country even though I have a home here almost paid for. I may have to go to sea again, but I am going to make a try at the power plant work once more.

I wish to cite an incident that has taken place here since this change. In charge of one of these plants was a man who had been in the service of one of these companies for 33 years. When the change over came, he thought he would have a better job all around, being retained at his former salary. When the heating season came around, he was requested to wheel all the coal and ashes, which was more than one man's job. When he refused to do so he was promptly discharged, after 33 years of satisfactory service to them. He is almost too old to look elsewhere for work. What is this man going to do for a living?

There is also another engineer who worked for the same firm here for eighteen years, but when the change over came they made a substantial reduction in his wages, so he was obliged to look elsewhere, but fortunately he had a farm of his own to go to. Some reward for engineering in these parts! B. W. HAY.

Bedford, Ind.

* * * *

Are Steam Air Preheaters Justified?

THE use of bled steam preheating of combustion air appears to be increasing rapidly in the United States, and although no data on which definite conclusions can be based have yet come to my notice, a number of descriptions of plants employing steam preheating have appeared recently in *Power*.

At least five large stations and possibly more are now working with this cycle, and the development is remarkable, for only two years ago the question was hardly out of the stage of discussion. At that time one plant at least was trying it as an experiment, and early in 1925 C. W. E. Clarke's paper on preheating, before the A.S.M.E., dealt with the subject fairly thoroughly. Mr. Clarke was not hopeful for the future of steam air preheating, but engineers seem to have thought differently. It is certain, however, that many engineers would welcome more facts and figures from existing plants with which they might be guided in forming their own conclusions.

In the modern power station employing the regenerative cycle for heating the feed water, there is no choice, as a rule, between an economizer and air heater of the flue-gas type, and we are forced to the use of the latter equipment. If full advantage is taken of the regenerative cycle, the flue-gas air preheater with the modern boiler must be large in order to obtain good over-all boiler efficiencies, and the temperature of the air to the furnace is high. This may not be a disadvantage with pulverized fuel, but many stokers, especially of the chain-grate type as now built, deteriorate rapidly with very high air temperatures. The alternative is to bleed steam to give a moderate preheat of the combustion air and put a large economizer behind the boiler, as at Saginaw, where the economizer is stated to be 91.7 per cent of the boiler heating surface. At the same time steam may be bled to heat the feed before the economizer, and this results in a gain in thermal efficiency of the unit. But the steam bled to heat the combustion air to obtain even a moderate temperature must be at about 50 lb. per sq.in. gage, and the loss of this steam lowers the thermal

efficiency of the turbine. If there is not a gain in boiler efficiency to balance this loss, the over-all efficiency of the plant will fall.

It is well established that there is a gain in combustion efficiency due to the use of preheated air. Normally, this gain is not large and usually lies between 1 and 3 per cent increase in boiler efficiency, but may, at very high burning rates, be somewhat higher. It is obvious that the reduction in turbine thermal efficiency that may be allowed for no change in over-all efficiency is not large. It has been reported at Riverside that the gains and losses balance.

I have taken a case in which the initial steam pressure is 375 lb. per sq.in. abs. and temperature 700 deg. F. With a vacuum of 1 in. of mercury the efficiency of the straight Rankine cycle is 36.2 per cent. Assuming an air-steam ratio of 1.6 and preheating the air from 70 to 230 deg. F., it is estimated that 6.72 per cent of the steam passing through the turbines must be bled at 57 lb. per sq.in. abs. if the steam in the air heater is assumed to be just condensed. At this pressure, with the adiabatic expansion assumed, the steam just reaches its saturation point in the turbine. The thermal efficiency then works out 35.1 per cent, and for no drop in over-all efficiency the boiler efficiency must increase over 3 per cent. I have allowed for the return of the air heater drips without loss to the condensate.

In practice, of course, the steam used to preheat the air is frequently taken from the evaporator, but this does not improve the figures. A smaller condenser and a decreased leaving loss will result and it would probably be cheaper to obtain a good boiler efficiency with a large economizer. In view of the narrow margin of improvement that may be expected, it would be interesting to have the views and experiences of engineers who are running these plants. B. M. THORNTON.

Cheshire, England.

* * * *

The Oil Engine Situation

A PORTION of my remarks on "The Oil Engine Situation" in the Jan. 3 issue was omitted apparently by mistake. The first paragraph should read as follows:

U. S. Census Reports made public this year have surprised many persons who were unaware of the dominating position the stationary oil engine has attained in the field of moderate-sized prime-movers. In the size range of 100 to 499 rated horsepower, 873 oil engines were manufactured in 1925; this is more than the combined number of steam engines and turbines, 241 and 355 respectively. Yet many engineers are still unacquainted with the characteristics of modern oil engines and with the actual costs of the power they produce.

These facts deserve attention. The power plant of moderate size containing units of 100 to 500 hp. capacity, is an essential factor in the industrial power field, and its importance is growing with the more general realization that, when motorizing a factory and obtaining the benefits of electrically driven machinery, it is not necessary to buy expensive electric current from a central station.

In many cases, where there is a large need of process heat coincident with the demand for power, the steam plant affords by far the cheapest source of power and heat combined. Considerable attention has been focused upon high-pressure boilers and upon turbines of the bleeder and back-pressure types. It is not surprising, therefore, that numerous steam plants are being installed in these days when technical developments find a welcome reception in the strong urge of cost reduction.

The low fuel consumption of the oil engine is well known, but the fact that the over-all cost of oil engine power is in many cases much less than that from other sources, is not so generally recognized. It is worthy of note, therefore, that despite the present restricted familiarity with oil engines and their costs, the use of them is increasing rapidly and has already reached the point where, in the size range of 100 to 500 hp., more oil engines are being manufactured than steam engines and turbines combined.

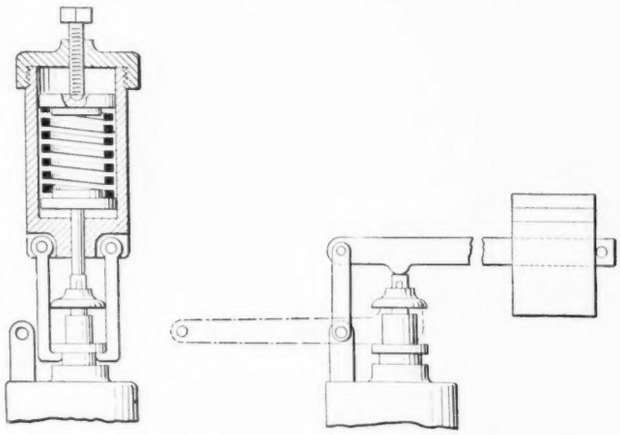
For the sake of their power costs it behooves power users and engineers to familiarize themselves with the modern oil engine. EDGAR J. KATES.

New York City.

* * * *

Boiler Inspector Has an Exciting Experience

THE article, "A Boiler Inspector Has an Exciting Experience," in the Nov. 15, 1927, issue of *Power*, has been of much interest to me. It describes how the pressure in a boiler, supposed to run at 100 lb., rose to



Screw and dead-weight clamps for holding safety valves while applying hydrostatic pressure

more than 250 lb., straining the boiler and narrowly averting serious consequences; all caused by the fact that on the day previous this boiler had been inspected and, in order that the hydrostatic test could be applied, the safety valve adjusting nut had been screwed down and then, through oversight, not released and reset to the proper working pressure.

In my opinion it is bad practice to screw the nut down on the safety valve spring, as this interferes with the correct setting of the valve. It is safer to use clamps on the safety valve if possible when boilers are subjected to hydrostatic test above their working pressure, as indicated in the illustration. One shows a screw clamp and the other a dead-weight clamp. Either one is easy to apply, does not interfere with the regular setting of the valve, and its removal is not likely to be forgotten when the test is over, because it is prominently visible.

Most of the safety valve troubles are due to the valve's being screwed down or blocked and then forgotten. With a little more precaution and co-operation between the engineer in charge and the boiler inspector, this serious risk could be eliminated to a large extent and boiler testing made safer.

Philadelphia, Pa. ALEXANDER KUZMANN.

* * * *

Automatic Boiler Blowdown in Proportion to Moisture Content of Steam

WITHOUT any desire to prolong the discussion on "Steam Purifiers vs. Steam Separators," it would appear that W. J. Hughes in his reply in the Nov. 22, 1927, issue, to my letter given in the Sept. 13 issue, has entirely ignored the data submitted by me in favor of the horizontal receiver type separator.

In the Sept. 13 issue it will be noted that evidence was given graphically in the form of the test tubes showing the high capacity of this type of separator or purifier.

RESULTS OF CALORIMETER TESTS

Time	Per Cent Moisture Before Steam Purifier	Per Cent Moisture Leaving Steam Purifier
1:06 Greater than	4	0.2
1:07 Greater than	4	0.2
1:08 Greater than	4	0.1
1:09 Greater than	4	0.2
1:10 Greater than	4	0.2
1:11 Greater than	4	0.2
1:12 Greater than	4	0.3
1:13 Greater than	4	0.2
1:14 Greater than	4	0.2
1:15 Greater than	4	0.2
1:16	2	0.1
1:17	2	0.1
1:18	2.8	0.1
1:19	2.7	0.1
1:20	1.6	0.1
1:21	1.2	0.1
1:22 Greater than	4	0.1
1:23	2.2	0.1
1:24 Greater than	4	0.1
1:25 Greater than	4	0.1
1:26	3.8	0.1
1:27	2.2	0.1
1:28 Greater than	4	0.1
1:29	3.5	0.1
1:30 Greater than	4	0.1
1:31	2.0	0.1
1:32	1.0	0.1
1:33	0.6	0.1
1:34	0.4	0.1
1:35	0.3	0.1
1:36	0.2	0.1
1:37	0.1	0.1

Fig. 2 also showed the trap discharges indicating that the purifier was constantly removing moisture and at intervals large slugs of water.

At the time that the letter given in the Sept. 13 issue was submitted, data were included showing that the moisture content in the steam leaving such a separator was much below one-half of one per cent.

Unfortunately, owing to lack of space, these data were not published. However, in another publication[1] under the title, "A New Application of Receiver Separators," these data are given more fully. The data and photographs of the test tubes clearly indicate the high capacity of this device. Incidentally, the test tubes do not represent samples taken when the data were determined. The test tube samples were collected when the test was made showing a moisture removal of as much as 40 per cent. The test tubes graphically illustrate that this was no exaggeration. It would seem, therefore, that the data submitted are sufficient to justify the arguments in defense of this particular type of separator.

The failure of ordinary separators in many cases is conceded. This is due to the fact that they may have been improperly designed, taking into account the velocities, and the drainage may not have been correct. In some cases the failures were due to the fact that ordinary separators were placed in superheater lines where the contamination existed in the form of dust so that they were rendered practically useless. In other cases the failure may have been due in part to the improper trap capacity, as Mr. Hughes suggests in his letter in the Nov. 22, 1927, issue.

I recall one instance where the superheater tubes became plugged inside of four days' time, but since the installation of these separators it is not necessary to clean the superheaters. This is in accordance with the last paragraph of Mr. Hughes' discussion, in which he states that "experience over a considerable period during which no deposits occurred in steam lines or prime movers, etc., is in the end the only basis for judging purifier efficiency."

It is, therefore, evident that this type of separator will perform the service equally as well as a steam purifier. Wherein lies, then, the distinction between the separator and the purifier?

C. E. Joos,
Philadelphia, Pa. Cochrane Corporation.

[1] *Power Plant Engineering*, Nov. 1, 1927.

* * * *

What Is the Practical Limit to Radiant Heat Absorption?

IN VIEW of the high rate of radiant heat transfer in water screens and water-cooled furnace walls that is being achieved, the following information may prove of interest to *Power* readers, and may in turn, induce other experimenters to present some interesting data.

In boiler furnaces the source of heat is chiefly carbon at a temperature of from 2,400 to 2,700 deg. F. In this case the maximum temperature was that of electric arcs, whose reputed temperature lies between 6,000 and 6,500 deg. F. The heating was, in part at least, done, therefore, by heat at the highest temperature commonly used in commercial heating.

RADIANT HEAT TRANSFER

Number of Coils	Water Velocity Ft. per Sec.	B.t.u. per Sq.Ft. per Hour
1	4.5	93,900
2	5.3	66,500
2	2.5	52,850

Two conditions were tried: In one a single copper coil surrounded the arcs, and in the other case two coils were used in parallel. In both cases the inner surface of the coil "viewing" the arcs was from 6 to 8 in. distant from them. The "dark" side of the tubing was from 1 to 2 in. from brick walls whose temperature was around 2,400 degrees.

The nominal outside diameter of the tubing was one-half inch, and the wall 0.031 in. thick. At the time the data were obtained, the copper was bright but had become coated with a hard scale at least $\frac{1}{32}$ in. thick, composed mostly of lampblack. Though this scale showed black on fracture, its outer surface was gray when cold. It is probable, however, that this scale, when fresh, had the characteristics in large measure of a black body, which has the capacity for maximum absorption and radiation of heat. The presence of this scale was evidence of some clouding with incandescent carbon particles of the region between the arcs and the tubing.

Detroit, Mich. ROBERTSON MATTHEWS.

New and Improved EQUIPMENT

Tagliabue Steam Operated Controller

A NEW type of steam operated controller which utilizes a portion of the steam in the pipe line which it controls to work the valves, the opening and closing of which governs the temperature of the apparatus to which the steam is admitted, is a recent development of the C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y.

Fig. 1 shows the assembly of the controller complete with the thermostat bulb and connecting tube, and Fig. 2 shows a cross-section through the controller head. The controller consists of three principal parts—the control valve *A* of the globe type, diaphragm *B* for operating the valve, and the pilot valve *C*.

Referring to Fig. 2, steam from the inlet side of the valve is admitted to the

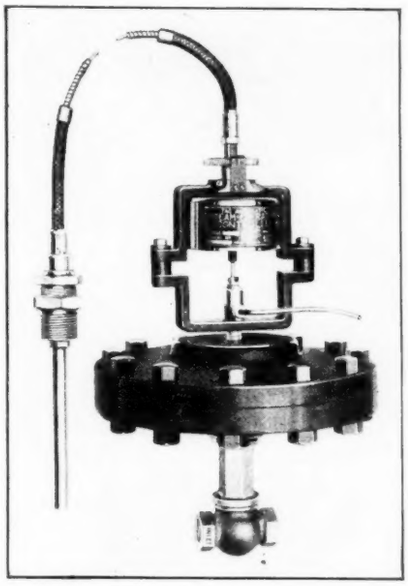


Fig 1—Assembly of controller with connections

chamber *D* below the diaphragm through the opening *E*, and also to the chamber *F* above the diaphragm through the opening *G* shown dotted in the upper end of the valve spindle *H*. If the steam in the chamber *F* above the diaphragm is not allowed to escape, the pressure on each side of the diaphragm will be equalized and the valve will be held to its seat by the spring *J*. But when the steam above the diaphragm is released at a faster rate than it is admitted through the opening *G*, the differential of pressure exerts an upward force on the diaphragm and the valve is opened against the pressure of the spring *J*. The amount of opening through the pilot valve *C* governs at all times the opening through the main valve *A* from "cracked" to full opening.

The pilot valve *C* is operated by a metallic bellows *K*, the movement of which is in turn controlled by a thermostat bulb inserted in the tank or other

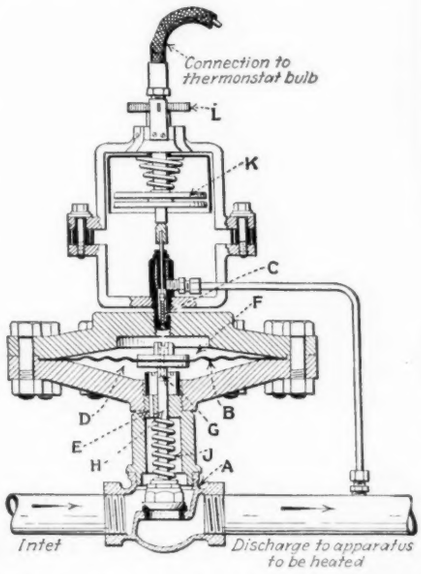


Fig. 2—Cross-section of controller head

vessel in which the liquid is being heated and to which steam is being admitted.

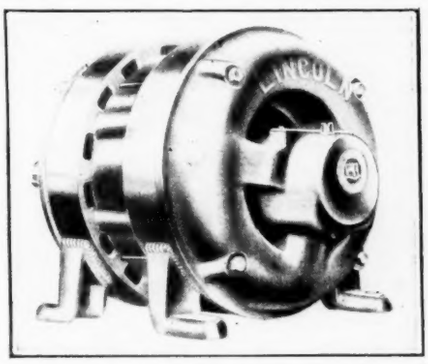
Adjustment of the setting point within the range of the controller is made by means of the knurled dial at the top of the controller head.

The controller is adaptable to a large number of services and is made in the direct-connected type shown, and the wall type in which the controller head is mounted on the wall at some convenient point remote from the valve that it controls.

The controller is designed to operate on pressures between 5 and 100 lb. and for use as temperature controller is furnished with a 40 deg. range anywhere between the limits of 95 and 290 deg. F. The size of the steam valve ranges in standard pipe sizes all the way from ½ to 4 in.

New Induction Motor for Across-the-Line Starting

THE Lincoln Electric Company, Cleveland, Ohio, announces a new line of squirrel-cage motors that are designed to be started by connecting directly to the power circuit. These motors are built in sizes from ½ to 30 hp. and for either two or three phase, 60 cycles. They are so designed that



Motor can be connected directly to line for starting

they can be started directly across the line without the use of a starting compensator, starting resistance or other voltage-reducing device, with a starting current below the requirements of the National Electric Light Association, rules.

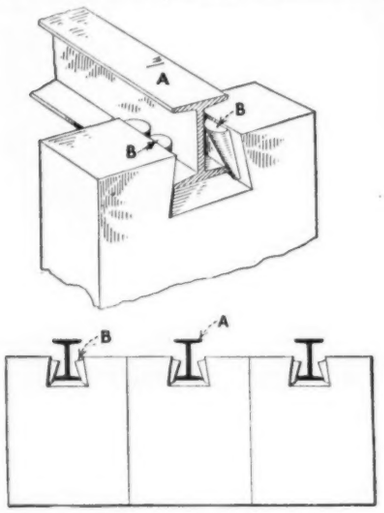
In this motor, power factor, efficiency, maximum torque, temperature rise, etc., have not been sacrificed in order to secure low starting currents. Tests show that starting torques of from full load to better than 250 per cent of full load, depending on the horsepower and speed, are possible without exceeding the N.E.L.A. requirements as to starting currents.

A comparison of the speed-torque curves of the new motor with the ordinary self-start motors shows that the former has equal or a slightly higher torque at zero speed. The curve of the new motor then shows a gradually increasing torque up to the maximum value, whereas curves of the ordinary self-start motors decrease to a value that is slightly above full-load torque and then increase to the maximum torque point. This gradually increasing torque of the new motor is desirable for starting many types of machinery. The new motor also has a high pull-out torque which is of considerable importance in that this motor will not stall on sudden overloads.

Burroughs Suspended Furnace Arch

THE illustration shows a type of suspended furnace arch recently developed by C. W. Burroughs, 303 Streatearn Ave., Montreal, Canada, with a view to simplifying the method of suspending the arch and facilitating the erection as well as the removal and replacement of individual tiles when repairs are necessary.

As will be readily apparent from the drawing, the arch is suspended directly from a series of parallel I-beams *A*, by



Detail of arch construction

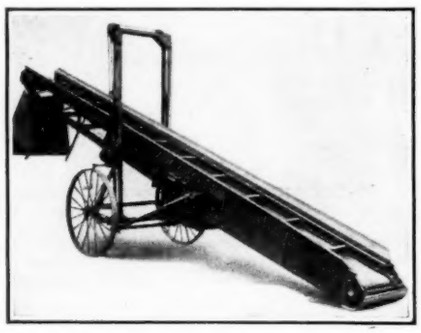
means of semicircular wedges *B* placed between the sides of the dovetail groove in the tile and lower edge of the I-beam.

With this form of construction the space required above the arch for the suspension member is reduced to a minimum and the removal and replacement of individual tile is facilitated, it being only necessary to push up the tile sufficiently to loosen the wedges and remove them and drop the tile out of place. A new tile is then readily inserted and secured in place by dropping the four wedges into place.

Jeffrey "Drag-On" Portable Scraper Conveyor

REDUCED weight of frame, increased size and strength of the conveying chain and larger screening chute are features of the portable conveyor "Drag-On," recently added to the line of conveying equipment manufactured by the Jeffrey Manufacturing Company, Columbus, Ohio.

The conveying chain is the combination type Jeffrey 188 Hercules. The flights, of quarter-inch steel plates, are L-shaped and run the full width of the trough. The bottom plates of the loading end of the trough are also of quarter-inch steel; these plates have been made extra heavy to stand the pounding of the coal in the loading pit. The screening chute is three feet long and gives six square feet of mesh for taking the fines out of the coal while loading. This mesh is welded from round bars. The conveyor is mounted on four-foot diameter wheels swiveled to turn in either direction, permitting the conveyor to make a complete circle around a fixed loading



Portable scraper conveyor

point. The wheels are bronze bushed and pressure greased. Power for the conveyor is supplied by an electric motor running on either ball or roller bearings as desired. The discharge end of the machine is raised or lowered by means of a worm-geared winch.

Pyro Optical Pyrometer

A TYPE of optical pyrometer which is self-contained and incorporates all the parts necessary for accurate temperature reading in one unit, has been brought out recently by the Pyrometer Instrument Company, 74 Reade St., New York City.

The instrument is used like a telescope; it magnifies the object four times and the object itself appears in its actual colors. The light rays of the object to be measured are concentrated through the objective *A* in such a way that they are thrown on the plane *B* of the system of prisms *C* and are clearly seen through the eyepiece *D*. The plane *B* of the prism has a small transparent test mark that appears to the eye as a small, clear and elliptical ring. This ring is lighted by a small electric lamp *E* by pressing the contact button *F*. The lamp receives current from a dry-cell battery *G* of approximately 60-milliamperes and can be adjusted by the rheostat *H* in connection with the milliammeter *J*. The small elliptical ring in the range of vision represents the standard brightness, burning with constant intensity by which the light of the observed body is compared.

In using the instrument (see Fig. 1), it is sighted in such a way that the test mark covers the object to be measured and the brightness of the range of vision is adjusted until the test mark disappears. For this purpose a circular color filter *R* with graduating density of color has been inserted between the objective *A* and the prisms *C*. This filter is rotated by the adjusting band *K* and filters the color of the object until the brightness of the test mark is matched. The temperature is then indicated on the scale *L*. Since all optical pyrometers work on monochromatic light, the red glass *M* is inserted after sighting by pushing the switch below the eyepiece before measuring the temperature.

Fig. 1—Pyrometer in position for indicating temperatures

In order to get a clear picture, the eyepiece *D* can be adjusted by rotation and the objective *A* can be moved by the guiding button *N* so that the image falls within the test mark.

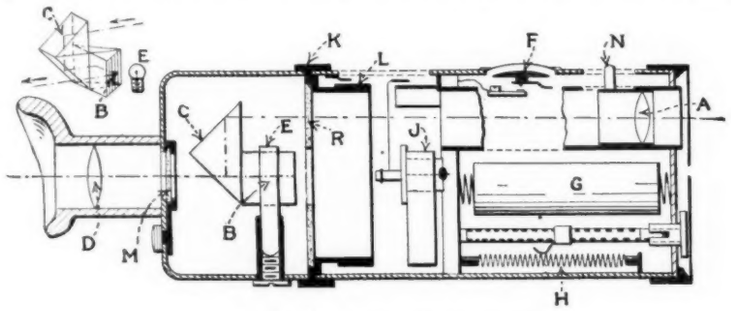


Fig. 2—Section through instrument

A master lamp is supplied with the instrument for checking the brightness of the service lamp. The normal range of the instrument is 2,000 to 3,200 deg. F. Special ranges for higher temperatures can be provided. The instrument is provided with a leather case and weighs only three pounds.

Progress in Steam Power Engineering

By John A. Hunter

Executive Committee Chairman A.S.M.E. Power Division

THE great increase in system loads and the more general use of large-sized power generating units have been important factors in making economically possible the notable achievements that have occurred during the last year. These achievements have not been confined to any one phase, but have taken place in almost all lines of the industry.

The trend in boiler development has been toward higher commercial efficiency. This has been secured by using larger units, higher pressures and ratings, water-cooled furnace walls and automatic control. Manufacturers report that boilers for 1,200 to 1,400 lb. pressure can be built without departing from the standard design except in minor details. In some cases, however, boiler design is being radically changed, as is seen in the extension of the use of the steam generator. Twelve of these units are either installed or under construction.

The desire to maintain high ratings has resulted in greater application of water-cooled side walls and bottoms. Originally developed as a protection for ashpits and refractory walls of pulverized-coal-fired boilers, water walls are being used in connection with all types of firing. The surface furnished by these walls has proved to be such an effective and efficient heat absorption medium that in some instances they are being installed for this purpose alone, the refractory protection being incidental.

Larger Boilers Being Installed

Central stations are installing larger and larger boilers to avoid having an excessive number of units. One plant has a boiler installed that has sufficient capacity to generate all the steam required by a 50,000-kw. turbine. This increase in capacity is due partly to larger units and partly to higher ratings. One station reports repeatedly maintaining an equivalent evaporation of 20 lb. per sq.ft. of surface for periods of six hours and over, and five other companies report having maintained evaporation rates of 14 lb. per sq.ft. of surface for short periods.

Cross-drum boilers having a heating surface of 35,500 sq.ft. and Stirling-type boilers having 41,500 sq.ft. are being installed and indicate the demand for larger units.

At the present time there are four boilers built for a pressure of 1,200 lb., the operation of which has been satisfactory, and maintenance costs have not been higher than for the lower pressures. The growth in the use of high-pressure units is further demonstrated by the fact that two new boilers to operate at 1,400 lb., containing 17,000 sq.ft. of heating surface, have recently been ordered and are the largest high-pressure units undertaken to date.

There has been an increase in the use of temperatures up to 700 or 750 deg. F., but no unusual change in superheat temperature or design has occurred. At least one manufacturer is ready to offer superheaters to furnish steam at a temperature of 900 deg. F.

THE Power Division of the American Society of Mechanical Engineers presented at the society's annual meeting a report of the progress made in steam power engineering during the past year, of which this is an abstract.

There is a definite increase in the use of air preheaters. The introduction of water-cooled walls and the regenerative cycle with its high-temperature feed water are to a great extent responsible for this.

Methods of Firing

Pulverized coal has continued its rapid advance with regard to the number and size of installations during the last year. At the present time over 45 public utility plants are operating or have under construction sufficient aggregate pulverized-fuel boiler capacity to supply steam for a turbine load of 2,640,000 kilowatts.

The demand for high rating has resulted in stokers of great size and fuel burning capacity. Forced-draft traveling-chain-grate stokers are made in sizes up to 525 sq.ft. of active grate surface, with a grate speed of 60 to 70 ft. per hour. The manufacturers claim these stokers will operate boilers at 500 per cent of rating continuously when burning Mid-Western coal. Underfeed stokers have made equally good progress. An Eastern station is installing stokers with 45 tuyeres that will feed coal for a distance of 16 ft. in furnaces 19½ ft. from the inside of the front wall to the rear breaker apron of the clinker grinders.

Of even more importance than the increase in fuel burning capacity is the use by stoker designers, of every improved element that has contributed to advance the design of boiler units, including preheated air, water-cooled walls and automatic control. It is significant that water-cooled walls with certain amounts of exposed refractory surface have been installed to an increasing extent during the last year.

Steam Piping—Feed-Water Treatment

During the last year the high-pressure stations have indicated a desire to simplify their piping systems and to eliminate as far as practicable the duplication of piping with numerous cross-over connections.

The American Engineering Standards Committee has completed its report covering "Tentative American Standards for Steel Pipe Flanges and Fittings for Pressures of 250 Pounds and Above, and Temperatures of 750 deg. F."

There have not been any outstanding developments in feed-water treatment during the last year. A caustic solution containing sodium aluminate has become more widely used both as a coagulant and as an accelerator in speeding up the reactions in lime-soda softening plants. Its use has materially reduced the total hardness of the treated water and at the same time has decreased the excess of reagents used in treating.

Embrittlement of boiler steel is still the object of considerable research work in this country and Europe. The investigation has resolved itself into studies of actual failures and laboratory experiments on the behavior of boiler steel when exposed to different strength caustic soda solutions.

Turbines

For several years the increase in size of turbines and generators has been rapid. To date the largest turbine is a 208,000-kw. cross-compound unit now under construction. The largest single-

cylinder unit in operation has a rated capacity of 65,000 kw. A single-cylinder unit of 75,000 kw. is being built and a tandem-compound turbine with a single generator rated at 160,000 kw. has been ordered.

Probably the most definite trend in turbine development is the marked preference of many engineers for still larger turbines of the single-cylinder design. As some of these engineers have previously been advocates of the two- or three-cylinder types, this development may have considerable significance.

There has been a decided growth in the use of 1,200- to 1,400-lb. pressure turbines and a still greater growth in the use of 600- to 650-lb. units. It seems, however, to be the consensus of opinion that about 400 lb. steam pressure is probably the most economical pressure for a plant with a small load factor or a low priced fuel. Wherever higher pressures are used, it is necessary to reheat the steam in order to overcome serious difficulties from wet steam in the last stages of the turbine. If this reheating is done in the boiler room, it requires large piping to and from the reheating boiler and also involves some loss in the pressure, which partly offsets the gain from reheating. One of the Chicago stations proposes to overcome this difficulty by reheating the steam near the turbine by means of high-pressure steam. This will be the first American installation of a live-steam reheater. It will be used in connection with a 90,000-kw. cross-compound turbine, and will reheat approximately 500,000 lb. of steam per hour to about 470 deg. F.

Mercury Vapor

One of the most interesting power station installations now in the course of construction is an addition to the South Meadow Station of the Hartford Electric Light Company. Following the experimental work done in the Dutch Point Station, the Hartford Electric Light Company is installing a five-stage 10,000-kw. mercury vapor turbine which will take mercury vapor at approximately 70 lb. pressure and 884 deg. F. and exhaust it at 1 lb. abs. to two mercury condensers that produce steam at 250 to 350 lb. pressure.

The year has witnessed an improvement in operating efficiency and the setting of new records in thermal economy. Probably the record thermal efficiency so far attained on a straight steam cycle is 27 per cent. The station establishing this record generates a net kilowatt-hour on 12,462 B.t.u. with a boiler efficiency of 87½ per cent, a coal rate of 0.89 lb., and a water rate of 7.85 lb. per kw.-hr. These figures represent the average for an entire month.

Industrial Power

Many of the developments with regard to power generation in the central stations apply equally well to the industrial plant. Some of these changes have been modified slightly: for instance, in industrial practice, where pulverized coal is used, the unit pulverizer has been the rule rather than the exception.

An increase in the electrical interconnection of industrial power plants with one another and with public utility power systems is noticeable. This arrangement gives all the units connected to the system a better load factor and seems to have considerable possibilities, especially in those plants having considerable waste heat available for power generation and in which the supply of waste heat does not occur at the time of the electrical peak load.

Switching Requirements for Industrial Power Systems

AT THE Philadelphia Engineers Club, on Saturday afternoon, Jan. 7, a symposium on switching equipment was presented before the Philadelphia section of the Association of Iron and Steel Electrical Engineers. Three papers were read: "Increased Requirements of Switching Equipment Due to Increased Capacity," by W. H. Andrews; "The Effects of Transient Phenomena on the Selection of Electrical Equipment," by E. G. Merrick; and "The Safety and Continuity of Service Angle," by E. O. MacFerran. All the papers were illustrated with numerous lantern slides.

Attention was called to the importance of continuity of service in steel-mill power plants. It is the only single feature of the mills operation that, if failure occurs, can shut down the whole works. The inadequate equipment in many steel mills was stressed. In other cases where the generating equipment is of the correct design, the switching equipment is not suitable. For the safety of these systems it is advisable to scrap much of this equipment and install new apparatus of sufficient mechanical strength to withstand the short-circuit stresses produced in the system.

When the power installations were first made, the equipment may have been suitable for the conditions at that time. The increased size of many systems, due to adding new and larger machines, by interconnecting with a central station system, or by doing both, has made the switching equipment entirely inadequate to handle short circuit or other abnormal conditions. The increased capacity tied into the system may be capable of feeding current into a fault that is far beyond the rupturing capacity of the old switches and may create forces beyond the mechanical strength of busbar and other structures. Furthermore, the layout of the equipment may be such that, if a severe short circuit started an arc, it is likely to involve a large part of the equipment and do serious damage before it is extinguished. Money spent to correct these conditions was considered good insurance against costly shutdowns that might cripple a whole steel works for a considerable period.

Careful attention should be given to limiting the amount of current that can be fed into a fault. Two 5,000-kw. generators with low reactance in the circuit can produce a more destructive current than a much larger plant capacity with higher reactance in the system.

Disconnect switches that were not locked closed, were pronounced a source of danger in the system, as they might be forced open by a heavy current such as occurs at the time of a short circuit. Disconnect switches designed for a normal current of 100 amperes will open if the current exceeds 5,000 amperes and a 600-ampere switch is likely to open if the current exceeds 15,000 amperes, unless the switch is locked in the closed position.

The condition of the oil in the switch is an important factor in safe switching operations. The oil should be able to stand a test of 22,000 volts without failure when applied by the standard method of testing, which is a 0.1-in. gap between the one-inch disk terminals. When the oil fails at 18,000 volts or less, it should be dehydrated and brought back to normal condition.

When the switch opens, particles of the oil are carbonized. When moisture is present in the oil, the carbon, which has an affinity for the moisture, tends to hold the moisture in suspension in oil. This action tends to destroy the insulating qualities of the oil. The particles of carbon and moisture being in suspension are attracted by the static field and collect on the switch insulation in the oil and may, under severe conditions, cause a flash over.

Regular inspection of oil switches was emphasized. The contacts should be kept in good condition and the oil maintained at the proper level. In one plant an oil switch is inspected if it spills oil when it opens a short circuit. If it does not spill any oil, it is allowed to open three short circuits before inspection. These inspections are in addition to the regular periodic inspections.

Attention was called to a number of plant interruptions that had occurred due to switch failures when interrupting abnormal currents. In all these cases the oil circuit breakers were capable of handling normal switching requirements satisfactorily.

The opinion was expressed that, when selecting switching equipment, a careful analysis should be made to determine the current that can be fed into a fault in different parts of the system. It is for these abnormal conditions that the switch must be selected.

NEWS *of the* FIELD

Federal Trade Commission Finds No Monopoly in Electrical Equipment Production

Tells Senate in Report Market Is Highly Competitive, With G. E., Westinghouse and Allis-Chalmers Dominating Trade—Few Complain of Recent Heavy Price Cuts

REPORTING to the Senate Jan. 11 on its investigation of electric equipment manufacturing in the United States, the Federal Trade Commission stated it had found no evidence that any company, or group of companies, had attempted a monopoly.

Small manufacturers informed the commission, the report said, that while the large companies undoubtedly have the power to crush them by price competition, this power had not been used in recent years.

COMPLAINT BY SOME MANUFACTURERS

The commission reported, however, that certain small manufacturers of fractional horsepower motors had complained that in recent years prices had been reduced to levels at which they have been unable to compete.

The report is the second and concluding document prepared in response to a Senate resolution adopted at the second session of the Sixty-eighth Congress.

The first volume, submitted last February, dealt primarily with the organization, control and ownership of commercial power companies, with special reference to the extent of control exercised by the General Electric Company.

The report said that the General Electric's output in recent years had represented from 16 to 20 per cent of the total value of electrical equipment manufactured in the United States, with the percentage averaging even higher for the more important units of electric power equipment.

FINDS THREE FIRMS DOMINANT

The General Electric, Westinghouse Electric & Manufacturing Company and the Allis-Chalmers Manufacturing Company, the commission said, dominate the trade in electrical equipment.

"The general opinion among many of the small manufacturers called upon," the report declared, "was that the General Electric and Westinghouse companies dominate the trade chiefly because of their financial resources, country-wide distribution and service organizations and control many of the largest wholesalers. There was some complaint of oppressive patent litigation, but no substantial evidence has been obtained on this point."

The commission called attention to the growing movement of power across state lines and the consolidation of large power units into "superpower" systems, for which there is no present provision for Federal regulation.

P. C. Brooks a Vice-President of Fairbanks, Morse & Co.

At a recent meeting of the Board of Directors of Fairbanks, Morse & Company the election of P. C. Brooks as a vice-president, was announced. During an association of twenty-nine years with the organization Mr. Brooks has held many positions of responsibility, and in addition to his present office he is president of E. & T. Fairbanks & Company, the scale manufacturing subsidiary of Fairbanks, Morse & Company. He is also vice-president of the Canadian Fairbanks-Morse Company, Ltd.

After graduating from Georgia Tech in 1891, where he studied mechanical engineering, he was connected with a number of manufacturing organizations and in 1899 he went to the Beloit Works of Fairbanks, Morse & Company where he became assistant manager and then acting manager. From this time on he was appointed to various positions of executive character. During the last ten years he has been actively directing the development of the scale business both in the United States and Canada.

Feather River, Calif., Project by Pacific Gas & Electric

The Pacific Gas & Electric Company has applied to the Federal Power Commission for a preliminary permit covering a project calling for eight power houses on the Middle and South Forks of Feather River near Quincy and Oroville, Calif.

The Pacific Gas & Electric Company plans to construct four storage reservoirs with 252,000 acre-feet of storage on the Middle Fork. One storage reservoir of 108,000 acre-feet capacity is proposed for the South Fork. The project includes the erection of five dams. One is to be 370 ft., another 175 ft., another 108 ft., the fourth 50 ft., and the fifth 20 ft. high. There are to be eight power houses, in which it is proposed to install a total of 360,000 hp.

Brooklyn Polytechnic Institute Raises Degree Standards

The Polytechnic Institute of Brooklyn, N. Y., has voted to raise the standard of its engineering degrees by increasing the requirements for these degrees.

Previously the degree of civil electrical or mechanical engineer has been granted upon the successful completion of four years of prescribed work. The degree of chemical engineer has only been granted upon the completion of five years of work. Under the new plan, which becomes operative with the class of 1932 which enters next September, the degrees of Bachelor of Civil, Electrical and Mechanical Engineer will be granted at the end of the regular four-year course.

American Engineering Council Board for 1928

The administrative board of the American Engineering Council for 1928 was announced Jan. 12, under the presidency of A. W. Berresford.

Those to serve as vice-presidents are L. P. Alford, O. H. Koch, I. E. Moultrop and G. S. Williams. Dr. H. E. Howe will serve as treasurer.

The representatives of the American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Society of Agricultural Engineers, American Society of Mechanical Engineers and the Society of Industrial Engineers are as follows:

American Institute of Chemical Engineers, H. E. Howe; American Institute of Electrical Engineers, John H. Finney, M. M. Fowler, H. A. Kidder, Farley Osgood, C. F. Scott, C. E. Skinner; American Society of Agricultural Engineers, O. W. Sjogren; American Society of Mechanical Engineers, Alex. Dow, John Lyle Harrington, O. P. Hood, Charles Penrose, E. N. Trump, D. Robert Yarnall; and the Society of Industrial Engineers, Dr. W. F. Rittman.

W. Winans Freeman Receives McGraw Medal for Co-operation

A brilliant gathering of many outstanding leaders in the field of the electrical industry, including a number of central station executives and prominent manufacturers, attended the presentation dinner of the James H. McGraw Award Medal for Co-operation tendered to W. Winans Freeman, chairman of the Union Gas & Electric Company, Cincinnati, and vice-president of the Columbia Gas & Electric Company, New York, at the Hotel Roosevelt the evening of Dec. 10.

One of four medals, which constitutes the James H. McGraw award given separately to men in the electrical industry, that presented to Mr. Freeman, was in recognition of his eight years of service as president of the Society for Electrical Development. The permanence of this award has been secured by Mr. McGraw through an endowment in the keeping of the Society for Electrical Development by whom the fund is administered. The other awards to be made annually are the Manufacturers Medal, the Jobbers Medal, and the Contractors-Dealers Medal.

The toastmaster of the dinner was Frank W. Smith, president of the United Electric Light & Power Company, New York. The speakers were James H. McGraw, president of the McGraw-Hill Publishing Company, donor; Howard T. Sands, vice-president of the Electric Bond & Share Company; Clarence L. Collens, president of the Reliance Electric and Engineering Company, Cleveland; Joseph A. Fowler, president of the Fowler Electric Company, Memphis; J. E. North, Cleveland Electric Illuminating Company, and P. G. Gossler, president of the Columbia Gas & Electric Company, of New York City.

The sponsoring committee for the presentation, which will be under the auspices of the Society for Electrical Development, is headed by Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston.

Offers Scholarships in Public Utilities Economics

Fifteen graduate scholarships and fellowships in the economics of public utilities have been announced by the University of Illinois for the year 1928-1929, according to information released by Dean Charles M. Thomson, College of Commerce and Business Administration, Urbana, Ill.

To third year graduate students three fellowships of $800 were provided, while five of $600 each will go to second-year graduate students, and seven of $400 to students of first year graduate work. Qualifications include a bachelor's degree from a class A college or university, demonstrated excellence in scholarship, and a proper foundation in scholarship. No applications will be received after March 1, it is stated.

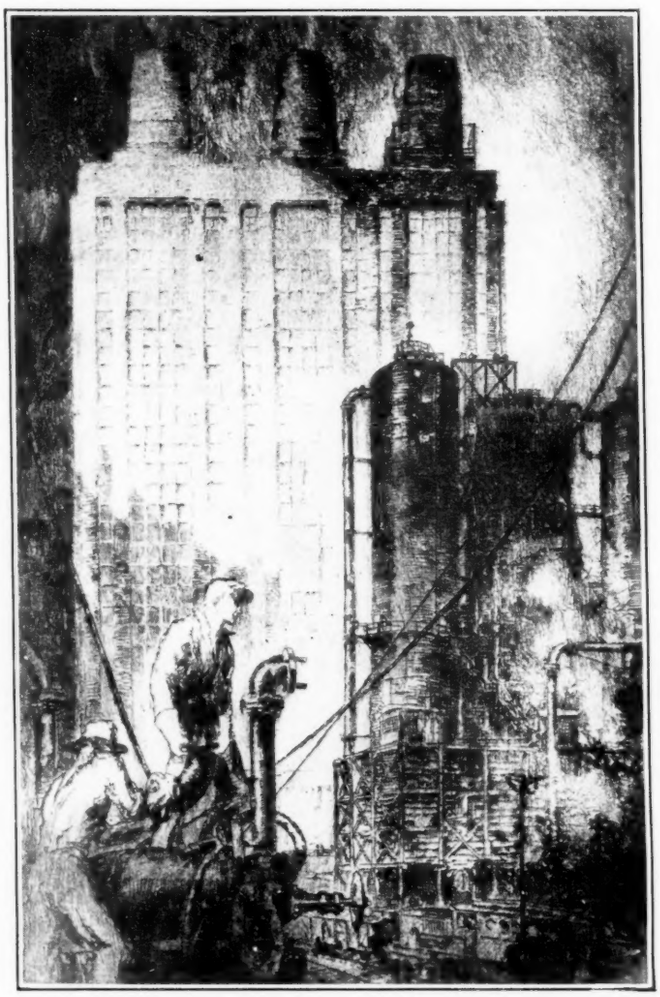
Great Lakes Power Co. Plans Plant on Montreal River

In consequence of the recent decision of the electorate of Sault Ste. Marie, Ontario, to enter into a power contract with the Great Lakes Power Company, that company will immediately proceed with investigations and surveys preparatory to the construction of a power plant on the Montreal River, to furnish additional power to the city necessary for the growing demand.

It is estimated that 25,000 hp. can be developed at the Upper Falls on the Montreal River. Lang & Ross, Ltd., and George Kohl, hydraulic engineer, will make the survey. The work of construction probably will take two years, involving an expenditure of about $2,500,000.

The Power Plant of Tomorrow

THERE are few speculative considerations of the future more inviting to either the artist or the engineer than the question of the power plant of the future. What will the ultimate of engineering progress hold out for us in this all-important matter of power and its byproducts? For the artist this thought is fertile with "fancies promising." And as he has learned through science much more of the world, and of himself, than his fellows of earlier days, knew the painter and the sculptor, each in his own medium, is turning to engineering and industry for subjects as his special heritage of modern time. Recently, O. Kuhler, the artist who has won wide recognition for his industrial etchings, had luncheon with several executives of the Combustion Engineering Corporation. The conversation turned to the power generating stations of the future, which many believe must be more than mere coal-burning steam-generating plants. That is, future development will not be based on the idea of coal as raw fuel to be burned, but rather as a raw basic product to be treated or processed, so that all of its constituent elements may be extracted for their fullest application; fuel for steam generation being only one of the products, or byproducts resulting.



"A Glimpse Into the Future"

Mr. Kuhler, with the adeptness of his calling, visualized the idea and conceived the etching, here reproduced, which he has called "A Glimpse into the Future."

Flood Waters Damage Plant of Niagara, Lockport & Ontario Power Company

Flood waters caused by an ice jam more than three miles long in the Oswego River, Jan. 4, resulted in damage to the power plant of the Niagara, Lockport & Ontario Power Company at Minetto, and several mills along the river suffered damage and were forced to shut down, being unable to obtain power.

State engineers used more than a ton of dynamite in efforts to break the jam and release the surplus waters into Lake Ontario, and it is probable that many more tons will have to be used before the river is entirely free of ice.

The power plant is 4½ miles south of Oswego and supplies power to the Syracuse-Oswego and other trolley lines. Jan. 5 the water was more than two feet deep in the motor room. An auxiliary power line running through from Syracuse was put in operation, and the trolley service has not been greatly affected.

No estimate of the damage to the plant itself has been made, but officials of the company stated that it will amount to several thousand dollars, according to report.

Favorable Report Seen on Swing-Johnson Bill

A favorable report on the Swing-Johnson bill on the Boulder Dam project will be made by the Committee on Irrigation and Reclamation of the House of Representatives. An announcement to this effect was made Jan. 10 by Representative Smith, of Idaho, the chairman of the committee.

However, Mulford Winsor, president of the Arizona Senate, appeared before the committee and urged that no legislation be enacted until an agreement can be reached by all of the states in the basin. It was declared that a similar view is held in Utah, Wyoming, Colorado, and New Mexico. Representative Douglass, of Arizona, told the committee that the bill "is unsound," attacking the measure because "it implicitly provides for additional appropriations in excess of the $125,000,000; by its very terms construction work cannot be begun before contracts for the sale of electrical energy are in hand; even though contracts in hand were necessary before construction work could be begun or expenditures made, it is impossible to obtain such contracts; the federal government can never be reimbursed for its expenditures even assuming that it could obtain contracts, and that in the absence of an agreement with Mexico, or pronouncement placing Mexico on notice, the construction of a dam at Boulder Canyon under the terms of the Swing-Johnson bill, will provide a regulated flow of water which can and will be so applied to beneficial use in Mexico that the southwestern part of the United States will be seriously affected in its agricultural development throughout its entire future."

Says Electrical Industry Outlook Bright in Canada

According to a statement recently issued by D. C. Durland, president of the Canadian General Electric Company, the outlook for the electrical industry in Canada is bright.

"With definite progress being made in manufacturing, agriculture, mining and building construction, Mr. Durland said in part there is bound to be reflected a greater use of electrical machinery and appliances of all kinds.

"In many instances the development of hydro-electric power and industry have gone hand in hand. One significant example of this was the building of the Gatineau newsprint mill of the Canadian International Paper Company, which is supplied with power from the hydro-electric stations on the Gatineau River. Another instance is the development of the Spruce Falls Pulp & Paper Company.

G. E. Orders Decline in 1927

Orders received by the General Electric Company during the year 1927 amounted to $309,784,623, compared with $327,400,207 for 1926, a decrease of 5 per cent, President Gerard Swope has announced. For the three months ended Dec. 31, orders amounted to $76,708,532, compared with $80,406,570 for the final quarter of 1926, also a decrease of 5 per cent.

Obituary

SENTER M. JONES, member of the American Institute of Electrical Engineers, first vice-president of the Century Electric Company, St. Louis, Mo., died suddenly Dec. 10. Mr. Jones was associated with the company since 1906.

W. C. CHAPPELL, for many years active in the field of electrical engineering and power development, and since 1909 a member of the A.I.E.E., died in late November at Clover Leaf Canyon, Monrovia, Calif., after a protracted illness. Born in England, Mr. Chappell had his early engineering training in England, Scotland, Germany and Austria. Comlng to this country, he served as erecting engineer at Philadelphia for the General Electric Company, and was later engaged in refrigerating engineering with Messrs. Gay & Son, Los Angeles, as design engineer. He also served the Tasmanian Government Hydro-electric Department under a three-year engagement.

Personal Mention

E. A. WAGNER has been appointed manager of the Pittsfield, Mass., plant of the General Electric Company.

B. L. DELACK has been appointed manager of the Schenectady plant of the General Electric Company the first of the year.

J. E. LEWIS, president of the Harbison-Walker Refractories Company, Pittsburgh, Pa., has been elected a director of the American Arch Company of New York.

PROF. ALEXANDER L. JENKINS, head of the department of mechanical engineering of the University of Cincinnati, is the new president of the Engineers Club of Cincinnati, having been appointed at a meeting in mid-January.

CLELAND C. ROSS, member of the A.S.M.E., has resigned his position as plant engineer of the American-LaFrance & Foamite Corporation, Elmira, N. Y., and is now chief engineer of the Kellog Manufacturing Company, Rochester, N. Y.

ROY WILKINS, member of the A.I.E.E., who for the last six years has been assistant electrical engineer in the hydro-electric department of the Pacific Gas & Electric Company, joined the Pacific Electric Manufacturing Company.

A. CARLE ROGERS, member of the American Society of Heating and Ventilating Engineers and the A.S.M.E., who has served for several years as superintendent of heating for the Toledo Railways & Light Company, has been appointed water commissioner for Toledo.

A. H. GRAYBURN, mechanical engineer and member of the A.S.M.E., formerly assistant secretary and assistant treasurer of the Norma-Hoffman Bearings Corporation, Stamford, Conn., resigned Dec. 31 to join the Hope Engineering & Supply Company, Mount Vernon, Ohio, and New York City.

STRICKLAND L. KNEASS, who last year received the John Scott Medal for his contributions to mechanical engineering, has established a fund for the purchase of books on thermodynamics for the mechanical engineering department of Rensselaer Polytechnic Institute, of which he is a trustee. Mr. Kneass was of the class of '80.

SIR RICHARD TETLEY GLAZEBROOK, who was in 1906 past president of the Institute of Electrical Engineers, London, England, has been elected chairman of the International Standards Association now under consideration, representing Great Britain. He is also chairman of the British Engineering Standards Association. Sir Archibald Denny recently resigned as chairman of both bodies.

OWEN D. YOUNG was elected chairman of the Economic Foundation, Jan. 4, succeeding THOMAS W. LAMONT, whose term as a member of the board of trustees had expired.

H. F. T. ERBEN, assistant vice-president of the General Electric Company, retired Jan. 1, after more than 40 years of service with that company. At the time of his retirement he was also vice-chairman of the General Electric manufacturing committee.

Society Affairs

A.S.M.E., BUFFALO: January 17, Hotel Statler at 8:00 p.m. Subject: "The Arteries of Industry," motion picture films, National Tube Co. W. P. Wooldridge will lecture. There will also be shown a film on building New York's newest subway by the Dupont Company.

A.I.E.E., CLEVELAND SECTION meeting at Hotel Statler, 8 o'clock, Jan. 19; "Today's Science, Tomorrow's Engineering," by L. A. Hawkins, General Electric Company.

A.S.M.E., BOSTON SECTION, Jan. 26: "The First Commercial 1,200 Lb. Steam Plant in the World"—I. E. Moultrop, chief engineer, Edison Electric Illuminating Company of Boston. Detailed notice to be sent later. Facilities will be available so that Section members and their guests may dine at the Club in advance of the meeting at 7:30 p.m., Engineers Club.

A.S.M.E., POWER DIVISION meeting at 29 West 39th St., New York City, 8 o'clock, Jan. 30; "What Is the Limiting Temperature in Central Station Operation?" V. T. Malcom, metallurgical engineer, Chapman Valve Manufacturing Company; A. M. Keenan, assistant engineering manager, Thomas E. Murray, Inc.

Business Notes

MCCLAVE-BROOKS COMPANY, manufacturer of McClave combustion systems, Scranton, Pa., is now represented in Dallas, Tex., by the company's former Southwestern district manager, D. G. Counts, 1204 Santa Fe Building.

FOOTE BROS. GEAR & MACHINE COMPANY has appointed S. W. Calhoun southeastern district representative with headquarters at Asheville, N. C. From this point Mr. Calhoun controls sales in the States of Tennessee, Kentucky, Virginia, North and South Carolina, West Virginia except the northern section handled from the Pittsburgh office.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Engineering Council, annual meeting will be held in Washington, D. C., Jan. 9-11; L. W. Wallace, executive secretary, 26 Jackson Place, N. W., Washington, D. C.

American Institute of Electrical Engineers, winter convention at New York City, Feb. 13-17, F. Hutchinson, secretary, 29 West 39th St., New York City; St. Louis Regional Meeting, District No. 7, March 7-9; Baltimore Regional Meeting, District No. 2, April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Society of Heating & Ventilating Engineers, hold general meeting at Hotel Pennsylvania in New York City, Jan. 23-26; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention at Hotel Stevens, Chicago, June 25-29.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National Association of Stationary Engineers, annual convention at Detroit, Sept. 11; Fred Raven, 417 South Dearborn St., Chicago.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association. Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

The National Marine Engineers' Beneficial Association, 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

THE C. O. BARTLETT & SNOW COMPANY, Cleveland, announces the appointment of William W. Dodge as its sales representative in western New York State. Mr. Dodge will make his headquarters in Warsaw, New York.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Jan. 12. 1928
Navy Standard	New York	$2.25@$2.75
Kanawha	Hampton Roads	1.63
Smokless	Cincinnati	2.25@ 2.50
Smokless	Chicago	2.25@ 2.50
S. E. Kentucky	Chicago	1.40@ 1.60
Steam	Pittsburgh	1.60@ 1.90
Gas Slack	Pittsburgh	1.15@ 1.35
Big Seam	Birmingham	2.00@ 2.25
Anthracite (Gross Tons)		
Buckwheat	New York	$2.85@$3.35
Birdseye	New York	1.60@ 1.85

FUEL OIL

New York—Jan. 12, light oil, tank-car lots, 24@26 deg. Baumé, 4¾c. per gal.; 28 deg., 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Dec. 28, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.50 per bbl.; 26@28 deg., $1.55 per bbl.; 28@30 deg., $1.60 per bbl.; 30@32 deg., $1.65 per bbl.; 32@36 deg., gas oil, 4.3c per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh — Dec. 19, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia—Jan. 6, 26@30 deg., $2.00@$2.06 per bbl.; 13@19 deg., $1.26 @$1.32 per bbl.; 22 plus, $1.58@$1.64 per bbl.; 27@@30, $2.10@$2.16 per bbl.

Cincinnati — Jan. 9, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Jan. 7, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Jan. 9, tank-car lots, f.o.b., 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5.8c. per gal.

Dallas—Jan. 7, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

THE AMERICAN ARCH COMPANY, INC., New York City, announces that G. S. Carrick has been appointed general manager of the industrial department. He will have full charge of all matters relating to the company's furnace products—the Type A unit supported wall, the Type C air-cooled blocks, American arches and other types of walls, roofs or bottoms. Mr. Carrick has had many years experience in power plant work. He served with the Westinghouse Company in the power plant department, later being transferred to the industrial sales department, having charge of sales in Southeastern district.

Trade Catalogs

AUTOMATIC SWITCHING EQUIPMENTS—The General Electric Company in Bulletin GEA-189A describes automatic switching equipments for indoor A-c, reclosing feeder service 440 to 7,500 volts. Illustrations include cuts showing motor mechanism and reclosing relay.

THERMOSTATIC RADIATOR TRAPS AND PACKLESS INLET VALVES—The Sarco Company, Inc., 183 Madison Ave., New York City, has issued a bulletin, "Who's Using Sarco," which is a partial list of Sarco installations in industrial buildings, hotels, apartment houses, hospitals, office buildings, schools and other public buildings.

THE IDEAL SYSTEM OF LUBRICATION—The Ideal Lubricator Company, 2120 Packard Building, Philadelphia, describes the Ideal System in a concise treatment published in illustrated bulletin form. This system consists of a central grease distributor which operates constantly and automatically from inner pressure and of regulating valves fitted at all bearing points. This distributor, ordinarily supplied with a capacity of six pounds, is a brass cylinder fitted with a column gage which indicates accurately at all times the amount of grease in the cylinder. The distributor is closed at both ends, the bottom end being fitted with connections for the purpose of introducing pressure under a piston, two of which are fitted to a common piston rod.

CHAIN GRATE STOKER FOR STEAM HEATING BOILER—The Boiler & Stoker Engineering Company, Inc., Grand Central Terminal Building, New York City, has issued a bulletin announcing the Metropolitan stoker, which embodies a new principle in chain-grate combustion making its application to steam heating furnaces possible.

BAFFLE WALLS—A new and practical bulletin has just been published by the Boiler Engineering Company, 931 Federal Trust Building, Newark, N. J. It shows a number of actual working drawings as well as photographs of typical installations. There are working drawings of vertical and horizontal types of practically every well-known make of water-tube boiler. The BECO contains positive expansion joints made possible by the BECO corrugated sheet metal separator, and claimed to be absolutely gas tight, "strong, rugged and durable." A copy of the bulletin will be sent on request.

STEAM PURIFICATION is the subject of a treatise printed in Bulletin 677 distributed by the Cochrane Corporation, Philadelphia. First are discussed the results of deposits in superheaters and erosion of valves and turbine parts. The causes of steam contamination, including priming, foaming and mechanical entrainment and their relation to concentration of boiler water, rapid changes in load, high water level, rate of steaming, etc., are next studied, after which the several types of steam purifiers are described and results of tests on such purifiers are presented. The publication closes with a discussion of the theory and practice of steam calorimetry, supplemented by a description of various types of calorimeters and sampling pipes, with hints on the location of sampling nozzles and the limitations of calorimeters.

NEW PLANT CONSTRUCTION

Calif., Culver City—Loyola College, J. A. Sullivan, Pres., is having preliminary plans prepared for the construction of nine college buildings near here. Estimated cost $5,000,000. T. F. Power, 2615 West 7th St., Los Angeles, is architect.

Calif., Likely—J. P. Booth, 140 North 18th St., San Jose, plans the construction of a hydro-electric power development including storage and diversion dams, etc. here.

Calif., Los Angeles—Los Angeles County Dentists Assn., c/o Parkinson & Parkinson, Title Insurance Bldg., Archts., is having preliminary plans prepared for a 13 story office building at 6th and Figueroa Sts.

Calif., Los Angeles—Merchants Ice & Cold Storage Co., 518 Seaton St., awarded general contract for the construction of an ice and cold storage plant. Estimated cost $100,000.

Calif., Montecito—City plans an election to vote $200,000 bonds for a sewage treatment plant and pumping station, etc. Burns & McDonell-Smith Engineering Co., Western Pacific Bldg., are engineers.

Calif., Westwood—Red River Lumber Co., plans the construction of a power plant and diversion dam to develop 3,436 hp.

Conn., Stamford—Richards & Co., Inc., 269 Ludlow St., awarded contract for the construction of a lacquer plant including 80 x 110 ft. boiler house, etc. on Ludlow St., to J. W. Ferguson, 152 Market St., Paterson, N. J. Estimated cost $80,000.

Ill., Chicago—A. M. Johnson, 77 West Washington St., will receive bids about Feb. 1 for the construction of an apartment building including electric refrigeration system, etc. at 4830 Drexel Blvd. Estimated cost $750,000.

Ill., Chicago—Woolworth Co., 608 North Michigan Ave., awarded general contract for the construction of an office and stores building at 26-30 North State St. and 9-21 West Washington St. to Starrett Building Co., 8 South Dearborn St. Estimated cost $2,000,000.

Ill., Silvis—Continental Ice Co., awarded contract for the construction of an ice manufacturing plant at First Ave. between 13th and 14th Sts., to Jacobson & Jacobson, 412 Oak Grove, Minneapolis, Minn. Estimated cost $300,000.

Mass., Brockton—Brockton Gas Light Co., G. H. Priest, Mgr., 54 Main St., is having plans prepared for addition to boiler plant on Grove St. Estimated cost $125,000. C. H. Tenney Co., 200 Devonshire St., Boston, is engineer.

Mass., Indian Orchard—United Electric Light Co., has acquired the water power rights formerly owned by the Indian Orchard Co., is revamping the hydro-electric installation to bring it up to date by installing two units, one to develop 3,000 hp. and the other 2,000 hp. McClintock & Craig, 458 Bridge St., Springfield, are engineers.

Mass., Lynn—Lynn Gas & Electric Co., 90 Exchange St., awarded contract for the construction of a boiler house in connection with discharge tunnel to R. E. Runnels Construction Co., Hildreth Bldg., Lowell.

Mass., Somerville (Boston P. O.)—City, L. M. Conwell, City Hall, Mayor, awarded contract for addition to high school including central heating plant to C. H. Cunningham & Co., 23 Central Ave., Lynn. Estimated cost $820,000.

Mich., Ann Arbor—City is having plans prepared for the construction of a sewage disposal plant and pumping station. Estimated cost $500,000. G. H. Sandenberg, City Hall, is engineer.

Mich., Battle Creek—City is having plans prepared for the construction of a sewage disposal plant and pumping station. Estimated cost $700,000. Fuller & McClintock, 170 Broadway, New York, N. Y., are engineers.

Mich., Owosso—Michigan Rubber Co., c/o Zimmerman Mfg. Co., had plans prepared for the construction of a factory including separate boiler room on South Cedar St. Estimated cost $50,000. Private plans.

Mo., St. Louis—Dubinsky Realty Co., Wainwright Bldg., has acquired a site and plans a 7 story apartment and stores building including steam heating system, etc. at Grand Blvd. and St. Louis Ave. Estimated cost $500,000.

Mo., St. Louis—T. H. Glancy, 4439 West Pine Blvd., is having preliminary plans prepared for a 10 story commercial building including elevators, etc. at Washington and 18th Sts. Estimated cost $1,000,000. C. H. Wray, Rialto Bldg., is architect.

Mo., St. Louis—C. Ulman, Paul Brown Bldg., is having preliminary plans prepared for the construction of two apartment buildings at Maryland Ave. and Kingshighway. Estimated total cost $2,000,000.

N. J., Camden—C. H. Moores, 110 East 42nd St., New York, N. Y., Archt., will receive bids until Jan. 14 for the construction of a cold storage plant at Front and Kaighn Sts. for Camden Rail & Harbor Terminal Corp., Camden, N. J. Moores & Dunford, Inc., 110 East 42nd St., New York, N. Y., are engineers.

N. Y., Binghamton—Dept. of Mental Hygiene, Capitol, Albany, will receive bids until Jan. 25 for the construction of a cold storage plant for Binghamton State Hospital here.

N. Y., Brooklyn—Brooklyn Garden Tenements, c/o A. J. Thomas, 2 West 46th St., New York, will build five 4 story and two 6 story apartment buildings here. Estimated total cost $1,500,000. Work will be done by separate contracts.

N. Y., New York—Four Hundred Eighty Tenth Ave. Corp., c/o S. Kheel, 315 7th Ave., is having plans prepared for a 21 story office and loft building at 10th Ave. and 37th St. Estimated cost $1,000,000. W. I. Hohauser, Inc., 17 West 44th St., is architect. Work will be done by separate contracts.

N. Y., New York—Irving Judis and Joseph Silverson, 52 Vanderbilt Ave., is having preliminary plans prepared for a 23 story hotel at 118-122 East 59th St. Estimated cost $1,750,000. Architect not selected.

N. Y., New York—A. E. Lefcourt Corp., 1351 Broadway, will build a 25 story office building at 38 Broadway. Estimated cost $5,000,000. Architect not announced. Work will be done by separate contracts.

N. Y., New York—Syndicate, c/o L. A. Goldstone, 420 Madison Ave., will build an apartment building at 136 East 79th St. Estimated cost $750,000. F. B. Hoffman, Jr., 147 East 51st St., is architect. Work will be done by separate contracts.

N. Y., New York—Julius Tishman & Sons, 285 Madison Ave., is having sketches made for a 15 story apartment building at 171 East 79th St. Estimated cost $1,400,000. Architect not announced.

N. Y., Poughkeepsie—Bacu Ice Co., High St. and Elm Place, is having plans prepared for the construction of a cold storage plant. Estimated cost $65,000.

O., Cleveland — The National Library Bindery Co., L. J. Bolz, Mgr., 1965 East 66th St., awarded contract for the construction of a factory and boiler house to The Austin Co., 16112 Euclid Ave. Estimated cost $62,000.

O., Cleveland—Northern Ohio Food Terminal Inc., C. Haas, 526 Broadway, is having preliminary plans prepared for a terminal building including cold storage plant, etc. at Orange and Croton Aves. and 37th St. Estimated cost $2,000,000. Wilbur Watson & Associates, 4614 Prospect Ave., are architects.

O., Mansfield—Farmers Savings & Trust Co., plans the construction of a 12 story bank and office building on Park Ave. Estimated cost $500,000. Althouse & Jones, are architects.

O., Portsmouth—City plans extensions and improvements to waterworks system including reservoir, filtration plant, pumping station, pumping equipment, etc. Estimated total cost $1,341,800. C. H. Anderson and J. H. Hiller, 2451 Madison Rd., Cincinnati, are engineers.

Pa., Huntington — Bd. of Trustees of Pennsylvania Industrial Reformatory, J. W. Herron, Gen. Supt., will soon award contract for the construction of a power plant.

Pa., Pittsburgh—Pittsburgh Hotels Corp., c/o William Penn Hotel, will soon award contract for a 24 story addition to hotel including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. at Oliver and Grant Sts. Estimated cost $4,000,000. Jansson & Cocken, Century Bldg., are architects.

Pa., Pittsburgh—The Pittsburgher Hotel, c/o H. L. Stevens Co., Archt. and Engr., will build a 24 story hotel including steam heating system, elevators, etc. on Diamond St. Estimated cost $2,000,000.

Tenn., Knoxville—Church Street Methodist Episcopal Church, R. R. Knickerbocker, is having preliminary sketches made for a 14 story church and office building. Estimated cost $1,000,000. J. R. Pope, 542 5th Ave., is architect. Barber & McMurray, Tennessee General Bldg., Knoxville, Tenn., are associate architects.

Tenn., Lebanon—Cumberland University, E. L. Stockton, Pres., plans the construction of a group of college buildings to include power plant, etc. Estimated cost $1,000,000.

Tenn., Memphis—Mr. Bowers Stores Corp., J. Fly, Pres., Linden Station, awarded contract for the construction of a warehouse including cold storage plant at Florida and Texas St. to Ozanne & Co., Empire Bldg. Estimated cost $300,000.

Tenn., Nashville—Neuhoff Packing Co., 1308 Adams St., awarded contract for the construction of a refrigeration plant to Foster-Creighton Co., Fourth and First National Bank Bldg., Estimated cost $40,000.

Tex., Brownwood — Brownwood Ice & Fuel Co., J. G. Lee, Mgr., will receive bids about Jan. 15 for addition to ice plant to increase the capacity from 75 to 100 ton. Estimated cost $60,000. Private plans.

Tex., Brownwood — Morgan Utilities Corp., M. B. Morgan, Pres., plans the construction of an electric light and power plant. Estimated cost $75,000.

Tex., Colorado—City is having surveys made for the construction of a municipal power and ice plant. Estimated cost $75,000. C. L. Root, Mayor.

Tex., Houston — City, O. F. Holcombe, Mayor, will receive bids until Jan. 18, for extensions and improvements to North Side sewage treatment plant including pumping station, etc. J. C. McVea, is city engineer.

Tex., Kingsland—Colorado River Hydro-Electric Co., Llano, is having surveys made for the construction of a hydro-electric power plant on the Colorado River near here. Estimated cost $300,000. Private plans.

Tex., Los Fresnos — B. Gentry, San Benito, will soon receive bids for irrigation work including pumping plant, etc., here. Estimated cost $350,000.

Tex., Pecos—Texas-Louisiana Power Co., plans the construction of a power plant, also extensions and improvements to ice plant to increase the capacity to 45 ton daily. Estimated cost $375,000. Private plans.

Tex., San Antonio—Hilltop Hotel Co., c/o H. C. Wood, Travis Bldg., is having preliminary sketches made for first unit of hotel. Estimated cost $500,000. Kelwood Co., 903 Travis Bldg., is architect.

Tex., South San Antonio — South San Antonio Ice Mfg. Co., G. Zumbel, Pres., plans the construction of a 50 ton ice plant. Estimated cost $60.000. Private plans. Work will probably be done by day labor.

N. S., Halifax — Avon Power Co. Ltd., plans a power development. Estimated cost $700,000.

Ont., Saulte Ste. Marie — Great Lake Power Co., Ltd., plans the construction of a power plant on Montreal River to develop 25,000 hp. Estimated cost $2,500,000.

Sask., Saskatoon—Mid West Utilities Co. Ltd., C. J. Torath, Pres., plans the construction of a power plant. Estimated cost $1,500,000.

Ont., Toronto—Womens College Hospital, 125 Rusholme Rd., is having plans prepared for a 9 story hospital including steam heating and refrigeration systems, elevators, etc. at Surrey Pl. and Grosvenor St. Estimated cost $1,000,000. Stevens & Lee, 62 Charles St., are architects.

Equipment Wanted

Boilers — Bureau of Standards, Dept. of Purchase, Washington, D. C., will receive bids until Jan. 23 for two 500 hp., 200 lb. pressure water tube boilers with superheaters, blowers, etc.

Boilers — U. S. Engineer, 428 Custom House, St. Louis, Mo., will receive bids until Feb. 15, for furnishing and installing new boilers, etc. in U. S. Dredge "Fort Chartres."

Boilers, Feed Water Heater, Stokers, Condensers, Etc.—Brockton Gas Light Co., G. H. Priest, Mgr., 54 Main St., Brockton, Mass., plans to purchase two horizontal return tubular boilers, feed water heaters, stokers and condensers for proposed addition to boiler plant.

Engine — Texas-Louisiana Power Co., Pecos, Tex., plans to purchase a 1,250 hp. Bordsberg high compression oil engine for proposed power plant.

Hoists—Bd. of Education, R. W. Rolman, Supt. of Plant Operation, 131 Livingston St., Brooklyn, N. Y., will receive bids until Jan. 18 for new electric ash hoists for James Monroe High School, New York, and P. S. 7, Long Island City, N. Y.

Ice Plant Equipment—South San Antonio Ice Mfg. Co., G. Zumbel, Pres., South San Antonio, Tex., plans to purchase machinery and equipment for proposed 50 ton ice plant.

Motor Control Equipment — G. Gross, County Clk., Oakland, Calif., will receive bids until Jan. 23, for motor control equipment for ventilating fans in connection with Oakland-Alameda Estuary tube project.

Pump—Montreal Water Board, City Hall, Montreal, Que., will receive bids until Jan. 27 for one 30 m.g.p.d. electric pump.

Pump, Etc.—Armona Public Utility Dist., Armona, Calif., plans to purchase a pump, etc., for proposed waterworks improvements. Estimated cost $26,000.

Pump, Engine, Etc. — City of Hollis, Okla., plans to purchase a 100 g.p.m. triplex pump, also 75 hp. gasoline engine for water plant.

Pump, Engine, Etc. — Hidalgo County Water Control & Improvement Dist. 6, Edinburg, Tex., plans the installation of a pump, engine and pumping equipment for proposed irrigation project.

Pumps, Motors, Switch, Etc. — City of Moreland, Okla., plans to purchase pumps, motors, automatic switch, etc. for proposed waterworks improvements. Estimated cost $35,000.

Pump and Motor—City of Verden, Okla., plans to purchase a deep well pump and motor for proposed waterworks improvements. Estimated cost $129,000.

Pumping Equipment—City of Woodriver, Ill., plans to purchase pumping equipment, etc. for proposed waterworks improvements. Estimated cost $100,000.

Pumping Unit—Bureau of Reclamation, Washington, D. C., will receive bids until Feb. 1 for one vertical motor driven screw or centrifugal pumping unit at Denver, Colo.

Pumps, Motors, Etc.—Sutter Basin Development Co., California Fruit Bldg., Sacramento, Calif., plans to purchase one 14 in. and one 22 in. centrifugal pumps with 60 and 150 hp. electric motors in connection with pumping plant for rice irrigation at Tudor, Calif., also 24 in. centrifugal pump with 150 hp. electric motor at Sutter City, Calif.

Refrigeration Machinery — Coleman Creamery, c/o R. B. Red, Mgr., Coleman, Tex., plans the installation of refrigeration machinery for proposed ice cream and refrigeration plant. Estimated cost $40,000.

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